ENGINEERING

An Illustrated Weekly Journal

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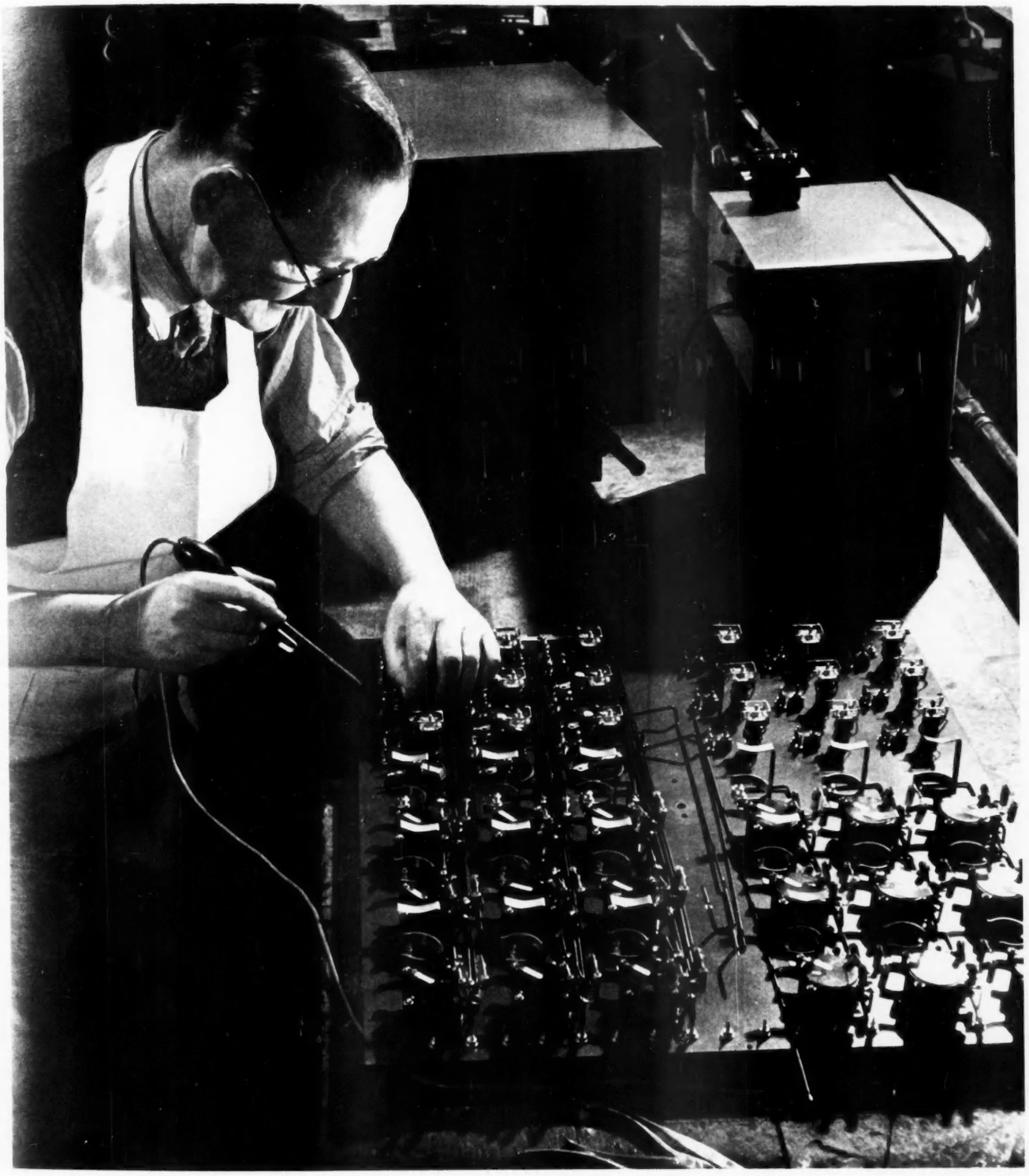

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The hydraulic governor is a complete vindication of the methods used by C.A.V. technicians. They set out to find the ideal governor for the high speed diesel engine—one which would give improved idling and excellent response to the accelerator, and yet was adaptable to meet the requirements of engines of many types. Above all, this unit had to be capable of giving years of trouble-free service.

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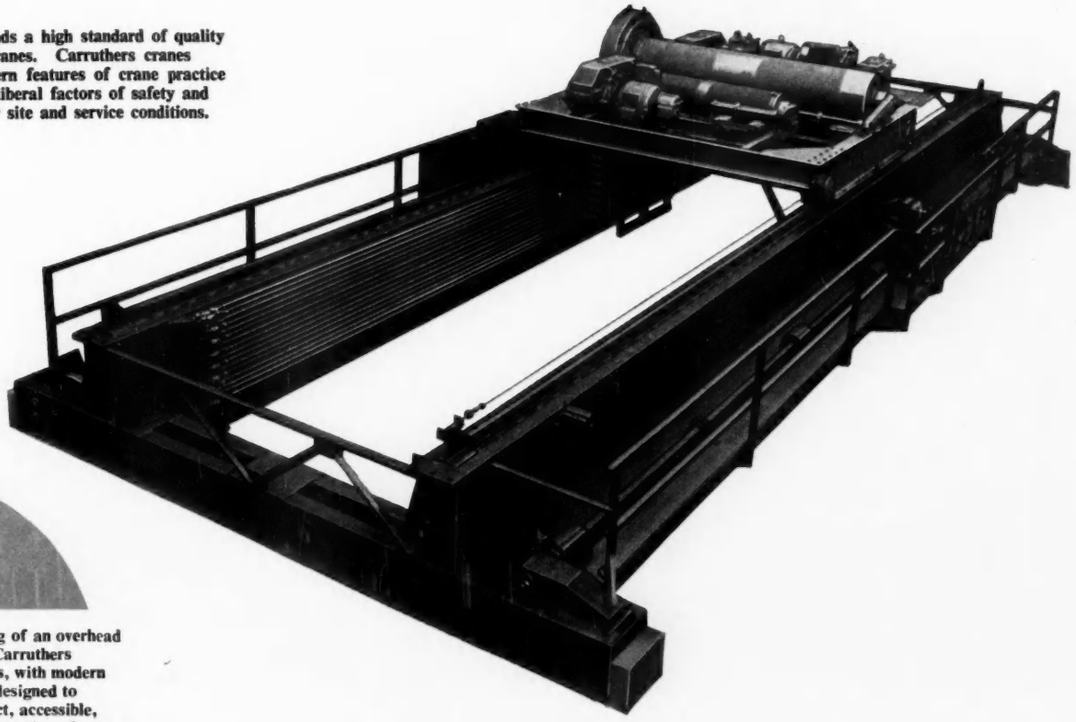
Modern industry demands a high standard of quality and dependability in cranes. Carruthers cranes embody the most modern features of crane practice and are designed with liberal factors of safety and wear to meet particular site and service conditions.



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A Power House of the Thames Board Mills treated with Miroglo. (Photograph by courtesy of Messrs. Thames Board Mills Ltd.)

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Unsurpassed for riveting, flanging, forming, or any purpose for which heavy plates, sections, etc., have to be manipulated and formed.

Makers of: PUMPS, ACCUMULATORS, RIVETERS, PRESSES, FOR FLANGING BENDING AND STRAIGHTENING, DEEP PRESSING, LEAD PIPE EXTRUSION, BALING STEEL SCRAP, WOOL, COTTON, Etc.

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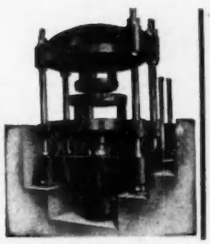
Hydraulic Flanging Press for Boiler and Tank end Plates. Several sizes. Any power.



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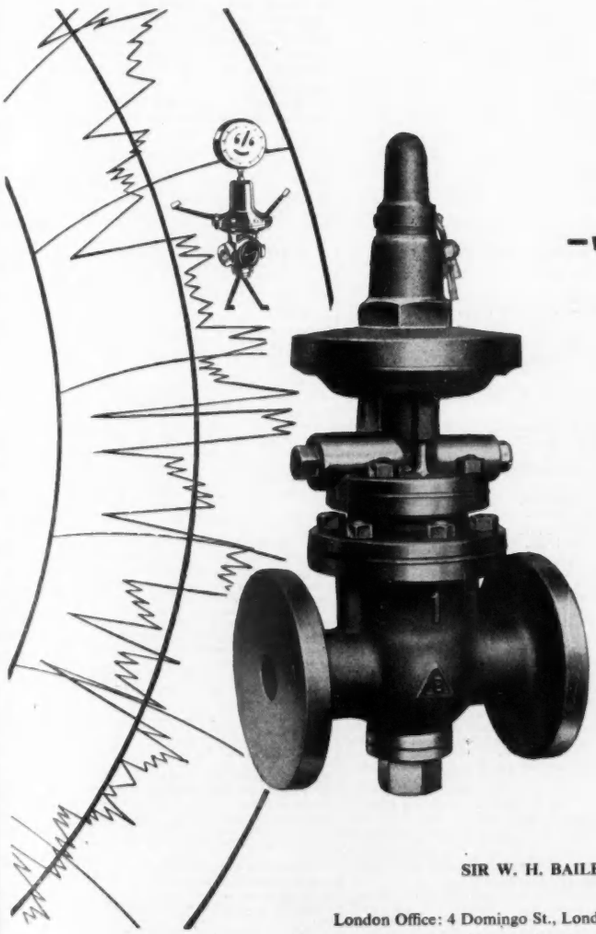

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Bailey's new 'G3' pressure regulators supersede the highly successful 'G2A' series. Stronger construction and greater ease of accessibility for maintenance are special features of this latest series in the Bailey range.

GREATER DURABILITY

The three points where the most wear takes place have been replaced to provide more durability. Pilot valve tops are now of forged bronze or alloy steel and valve and seat materials are harder.

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Spring chambers, pilot valve assembly, and the separate pilot valve strainer are all easily accessible.

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Please write for leaflet giving full details.

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BV. 10.

CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be 12s. for the first four lines or under and 3s. per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of 36s. per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is 2s. per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings £25 per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2. Inclusion of advertisements must be dependent on space being available.

PUBLIC NOTICES.

THE UNIVERSITY OF MANCHESTER.

POST-GRADUATE COURSE IN SOIL MECHANICS.

A full-time post-graduate course in Soil Mechanics will be held in the University of Manchester from July 9th to 20th, 1956. This course is intended for engineers whose work involves Soil Mechanics and who wish to study and discuss the latest developments in the subject. Participants should have a knowledge of the subject at text-book level. Members of the course will be accommodated in a hall of residence. The fee is £30 inclusive of accommodation and meals.—Further particulars may be obtained from the REGISTRAR, THE UNIVERSITY, MANCHESTER, 13. J 808

A CAREER AS A REGULAR ARMY OFFICER FOR QUALIFIED ENGINEERS.

MECHANICAL, ELECTRICAL AND ELECTRONIC ENGINEERS are required as officers in the Corps of Royal Electrical and Mechanical Engineers.

THERE ARE TWO METHODS OF ENTRY. These are either :—

(1) On a short service commission (which offers a good opportunity of obtaining a permanent commission) with a gratuity of about £100 for each completed year of service on leaving; or

(2) On a Permanent Regular Commission with a valuable pension and a terminal Grant of £1000 (tax free).

Candidates must be physically fit and between the ages of 23 and 28 years old (except for those with previous service in the Armed Forces, who may be 30 years old). They must have passed or be exempt from the examinations of either the Institution of Mechanical Engineers or the Institution of Electrical Engineers, or have a University Degree in Natural Science or Engineering. In addition, 2½ years' experience as an engineer (or 1½ years in the case of University graduates) is normally required. Additional seniority is given for an honours degree and for approved engineering experience.

The pay which Army officers may expect is according to the following table :—

RANK	NORMAL	IF SINGLE	IF MARRIED
Lieutenant ...	23	£686	£732
Lieutenant ...	25	£723	£860
Captain ...	27	£866	£1005
Major	34	£1193	£1330
Lt.-Colonel ...	42	£1512	£1640
Colonel	45	£1795	£1922
Brigadier ...	49	£2068	£2187
Major General ...	49 or over	£2634	£2744

(NOTE.—This is the U.K. scale; there are various additions in certain overseas stations.

In this table the figures of a single officer's pay include an element for food and accommodation which are normally provided in kind. This has been made to provide a direct means of comparison with civilian scales of pay.)

For further details please write to :—
THE WAR OFFICE (P.A.6(b)), LONDON, S.W.1. and quote this announcement. J 809

UNIVERSITY OF GLASGOW.

I.C.I. RESEARCH FELLOWSHIPS.

Applications are invited for I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology or Physics, to which some appointments may be made during the current academic year. The appointments will date from 1st October, 1956. The Fellows will hold the status of Lecturers in the University. The salary will depend upon qualifications and experience, but will be within the range £600-£900 per annum, together with F.S.S.U. benefits and family allowances. Applications (8 copies), with a list of publications and names of two referees, should be sent not later than 29th February, 1956, to the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court. J 843

EDUCATIONAL.

FREE. Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. E.M.I. INSTITUTES, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.). G 619

EXPERIMENTAL WORK.

RESEARCH ENGINEERS LIMITED,

Northampton Grove, Canonbury, London, N.1. Canonbury 4244/5/6. We have over 25 years' experience of experimental work and prototypes. We design, develop and manufacture special purpose and labour saving machines, all at the above address. Our range is from the smallest scientific instruments to 3- or 4-ton machines. After a prototype machine has been made and found satisfactory we can manufacture as many as are required in our Works.

G 656

CONSULTANTS.

TEAM OF DESIGNERS available for Mechanical and Production Engineering Special Machines and Projects. NORRIS BROTHERS, LTD., 53, Victoria Street, London, S.W.1. Tel.: Abbey 5444. G 530

TENDERS.

METROPOLITAN WATER BOARD.

WALTON SOUTH RESERVOIR.

The Board intend to invite

TENDERS in the Spring of 1956 for the **COMPLETION OF WALTON SOUTH RESERVOIR** and are prepared to consider applications from contractors to be placed on a list of selected firms who will be invited to submit tenders.

The reservoir will be situated near Walton-on-Thames in the County of Surrey. It will have a capacity of about 4300 million gallons, a depth of about 57 ft., and will cover an area of about 374 acres. The principal works involved are **1¼ MILES OF CUT OFF TRENCH, AN EARTH EMBANKMENT CONTAINING ABOUT 3 MILLION CUBIC YARDS WITH A CENTRAL PUDDLE CORE WALL, INLET AND OUTLET WORKS AND TWO TUNNELS EACH ABOUT HALF A MILE LONG.**

Further particulars of the works may be obtained from the Chief Engineer.

Firms applying to be placed on the selected list should submit full particulars of contracts for works of a similar character and magnitude which they have carried out, together with experience in tunnelling in the London clay, and also furnish financial references.

Applications to be placed on the list of selected firms should be addressed to the CHIEF ENGINEER at the offices of the Board to arrive not later than Wednesday, 25th January, 1956.

S. D. ASKEW,
CLERK OF THE BOARD.

OFFICES OF THE BOARD,
NEW RIVER HEAD,
ROSEBERY AVENUE,
LONDON, E.C.1. J 745

GOVERNMENT OF IRAQ.

DEVELOPMENT BOARD AND MINISTRY OF DEVELOPMENT.

NASIRIYAH ROAD BRIDGE
CONTRACT B/8 (1956)

THE DEVELOPMENT BOARD AND MINISTRY OF DEVELOPMENT invites

TENDERS from experienced Civil Engineering Contractors for the construction of a **STEEL CANTILEVER ROAD BRIDGE** approximately 180 metres long and 11 metres wide over the River Euphrates at Nasiriyah, together with the **STEEL AND REINFORCED CONCRETE APPROACH VIADUCTS** and embankments thereto.

The Contract Documents and Conditions as to Tendering may be inspected on and after the 17th day of January, 1956, at any of the following places:—

(a) The offices of the DIRECTORATE GENERAL OF LEGAL AFFAIRS AND CONTRACTS, MINISTRY OF DEVELOPMENT, BAGHDAD, IRAQ.

(b) THE EMBASSIES AND LEGATIONS OF IRAQ IN WASHINGTON, PARIS, ROME, BRUSSELS, BONN, CAIRO, KARACHI AND NEW DELHI.

(c) The offices of RENDEL, PALMER & TRITTON, 125, VICTORIA STREET, LONDON, S.W.1, ENGLAND.

Firms desiring to Tender may obtain two copies of the Contract Documents between the 17th day of January, 1956, and the 17th day of March, 1956 (both days inclusive) from the DIRECTORATE GENERAL OF LEGAL AFFAIRS AND CONTRACTS, MINISTRY OF DEVELOPMENT IN BAGHDAD, or the offices of RENDEL, PALMER & TRITTON IN LONDON, upon payment of twenty-five Iraqi Dinars or the equivalent thereof for each two sets of documents.

Tenders must be accompanied by a deposit of I.D. 10,000/- (Ten thousand Iraqi Dinars) either in cash or by a letter of guarantee to be made by or through an approved Bank established in Iraq. Fully detailed conditions as to this deposit may be ascertained from the "Conditions of Tender" attached to the Contract Documents.

Tenders must be submitted to the DEVELOPMENT BOARD (DIRECTORATE GENERAL OF LEGAL AFFAIRS AND CONTRACTS, MINISTRY OF DEVELOPMENT), BAGHDAD, IRAQ, in sealed envelopes endorsed clearly on the outside with the words "NASIRIYAH ROAD BRIDGE," and will be received up to noon on the 17th day of April, 1956.

A Memorandum of Capacity, Method of Procedure and Articles of Association must be submitted at the same time.

Particular attention is drawn to Clause 8 of the "Conditions of Tender" stating that tenders will be accepted only from firms of Contractors who have previously executed works of a similar character and magnitude.

Tenders not submitted within the time specified or not accompanied by a receipt of the deposit, or a letter of guarantee or if the Tenderer resides in a Liwa in Iraq where a Chamber of Commerce exists, by a Certificate of Membership of a Chamber of Commerce, shall be neglected.

The Board does not bind itself to accept the lowest or any Tender.

MINISTER OF DEVELOPMENT. J 737

GOVERNMENT OF INDIA.

MINISTRY OF RAILWAYS (RAILWAY BOARD).

TENDERS are invited for the supply of machines of undermentioned groups :—

1. **VERTICAL AND HORIZONTAL LATHES AND TURRET LATHES.**
2. **VERTICAL AND HORIZONTAL DRILLING MACHINES.**
3. **MILLING MACHINES.**
4. **PLANING, SHAPING AND SLOTTING MACHINES.**
5. **GRINDING MACHINES.**
6. **MATERIAL TESTING MACHINES.**
7. **GUILLOTINE SHEARS.**
8. **SHEET AND SECTION STRAIGHTENING MACHINES.**
9. **PRESS BRAKES.**
10. **ECCENTRIC AND HYDRAULIC PRESSES.**
11. **ELECTRIC WELDING MACHINES.**
12. **OXY-ACETYLENE PROFILE CUTTING MACHINES.**
13. **MATERIAL CUTTING AND FILING MACHINES.**
14. **FORGING FURNACES.**
15. **FORGING MACHINES.**
16. **PIPE BENDING MACHINES AND PIPE THREADING.**
17. **ANODISING PLANT, NICKEL AND CHROMIUM PLANTING PLANT.**
18. **GRIT BLASTING PLANT.**

Tender forms as well as "Instructions to Tenderers" and "Conditions of Contract," may be purchased from MESSRS. SWISS CAR AND ELEVATOR MANUFACTURING CORPORATION LTD., SCHLIEREN-ZURICH, SWITZERLAND, at a ground rate of S.Fr.5—and an additional rate of S.Fr.10—per machine group, payable to the CREDIT SUISSE ZURICH (Switzerland) for account Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, from 2nd January, 1956.

All tenders, with specifications, catalogues, drawings, etc., must reach the office of MESSRS. SWISS CAR AND ELEVATOR MANUFACTURING CORPORATION, LTD., SCHLIEREN-ZURICH, SWITZERLAND, not later than 1st March, 1956. J 807

COMMISSIONER FOR RAILWAYS.

NEW SOUTH WALES, AUSTRALIA.

TENDERS are invited for the **SUPPLY AND DELIVERY F.O.B. BRITISH OR CONTINENTAL PORT OF 12,000 ENGLISH TONS OF 107 LB./YARD FLAT BOTTOMED MEDIUM MANGANESE STEEL RAILS.**

Specification, drawings, and tender forms may be obtained from the AGENT-GENERAL FOR NEW SOUTH WALES, 56, STRAND, LONDON W.C.2, to whom tenders are returnable until 10 a.m. on Wednesday, 8th February, 1956. J 828

PUBLIC APPOINTMENTS.

ROYAL AIRCRAFT ESTABLISHMENT TECHNICAL COLLEGE, FARNBOROUGH, HANTS.

Applications are invited for appointments in the above selective day College as :—

ASSISTANT LECTURER IN MECHANICAL OR PRODUCTION ENGINEERING, and

ASSISTANT LECTURER IN MATHEMATICS.

DEMONSTRATOR IN MECHANICAL ENGINEERING.

DEMONSTRATOR IN ELECTRICAL ENGINEERING.

Candidates should hold a University degree or equivalent qualification and preferably have had some teaching and/or industrial experience.

The successful candidates for Assistant Lectureships will be required to teach in courses leading to Higher National Certificates. Specialist qualifications in Applied Thermodynamics or Workshop Technology, while not essential, will be considered an advantage. Posts will be ranked as Grade A or B in accordance with the experience and qualifications of the successful candidates.

The successful candidates for Demonstratorship will be required to assist in the organisation, preparation and control of work in the laboratories under the guidance of Senior Lecturers. Some teaching of appropriate subjects will be involved. Facilities for further study and/or research may be available. The posts will be ranked as Grade A.

The salaries payable are in accordance with the Burnham Scale for Teachers in Technical Colleges and are subject to the Teachers' Superannuation Acts. The salary scales for Grades B and A are £525 by £25 to £820 and £450 by £18 to £725, respectively, with allowances for qualifications (£90 for a good degree) and training, the commencing salary being in accordance with experience.

Further particulars and application forms may be obtained from the PRINCIPAL OF THE COLLEGE, to whom completed forms should be returned within fourteen days of the publication of this announcement. J 811

MINISTRY OF HOUSING AND LOCAL GOVERNMENT.

INSPECTOR OF ALKALI, ETC., WORKS. The Civil Service Commissioners invite applications from men for a pensionable post as Inspector under the Alkali, etc., Works Regulations Act, 1906. Headquarters in Bristol, but considerable travelling involved. Age at least 35 on 1st December, 1955. Candidates must be university graduates in science or technology and preferably also Corporate Members of the Institution of Chemical Engineers or Fellows or Associates of the Royal Institute of Chemistry, but exceptionally a candidate possessing other appropriate qualifications and of outstanding ability may be admitted. A wide working experience of the heavy chemical and related industries is essential. Starting pay (for 45½-hour week), £1293 at age 35 up to £1375 at 37; (exceptionally, higher at 37 or over if outstandingly well qualified). Inclusive maximum £1577.

Application form and particulars from CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, 30, OLD BURLINGTON STREET, LONDON, W.1, quoting No. S4541/56. Applications to be returned by 31st January, 1956. J 810

STATES OF JERSEY.

SEWERAGE BOARD.

APPOINTMENT OF ASSISTANT CIVIL ENGINEER.

Applications are invited for the appointment of **ASSISTANT ENGINEER** in the office of the Consultant Engineer to the Board at a commencing salary within the range £700 to £800.

The successful applicant would be principally engaged on design of works in connection with the Island Main Drainage and Sewage Treatment Scheme for a population of 60,000. Where possible, opportunity for outside experience will be given.

Applicants should preferably be between 20 and 30 years of age, have some practical experience in sewerage or reinforced concrete work and have passed sections A and B of the Institute of Civil Engineers examination, or have some equivalent qualification.

The appointment is a temporary one, but is expected to last for at least two years. It would be terminable by one month's notice on either side. Salaries will be fixed in accordance with qualifications and experience, and an annual increment will be payable subject to satisfactory service.

Applications, stating age, whether married or single, giving full details of training, qualifications, present and previous appointments, and accompanies by copies of two recent testimonials must be delivered not later than 10th January, 1956, to the GREFFIER OF THE STATES, STATES' GREFFE, JERSEY, C.I.

The States of Jersey can undertake no responsibility for the provision of housing accommodation. J 628

CENTRAL ELECTRICITY AUTHORITY require a **SENIOR ASSISTANT ENGINEER (BOILER PLANT)** to conduct investigations into the economic and design aspects of large future boiler plant installations for high pressures and temperatures and their major auxiliary equipment, with particular respect to combustion, stress and chemical engineering considerations. Candidates should preferably be Corporate Members of the I.Mech.E. or I.Civil.E. and have experience in the manufacture or design of boilers or chemical plant. Salary within Grade I N.J.B. £1150-£1500 p.a. inclusive.—Applications to D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, to arrive not later than 20th January, 1956. Quote ref. AE/725. J 752

CITY OF LEICESTER EDUCATION COMMITTEE.

COLLEGE OF TECHNOLOGY AND COMMERCE, THE NEWARKE, LEICESTER.

Principal: R. E. WOOD, M.Sc., F.Inst.P.

Applications are invited for the post of

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING. Applicants should have a Degree or equivalent qualification, together with industrial and teaching experience.

Salary in accordance with the Burnham Technical Scale for Lecturers, £965 by £25 to £1065 per annum.

Forms of application can be obtained from the REGISTRAR, to whom they should be returned as soon as possible.

ELFED THOMAS,
Director of Education. J 794

THE N.I.A.E. SCOTTISH STATION.

EXPERIMENTAL OFFICER OR ASSISTANT EXPERIMENTAL OFFICER required. Duties: problems of grain drying, design and construction of experimental agricultural equipment, field tests. Qualifications, O.N.C., H.N.C., or equivalent in mechanical engineering. Apprenticeship an advantage.

Salary scale—Experimental Officer, £745-£920 per annum; Assistant Experimental Officer, £311 10s.-£670 per annum.

Further particulars of commencement, salary and superannuation from the SECRETARY, N.I.A.E. SCOTTISH STATION, HOWDEN, MID CALDER, MIDLOTHIAN. J 790

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKSHIRE,

requires :

ENGINEERS (Main and Basic Grades)

to assist senior staff engaged on planning and/or maintenance of all types of radio-active and conventional laboratories and workshops with their ancillary plant and services. Applicants should have served a recognized apprenticeship and be corporate members of one of the Institutions of Civil, Electrical or Mechanical Engineers, or have exempting qualifications. Experience in any of the following specialized fields would be advantageous :—

Ventilation and Extract Plant.
Electric power generation and distribution.
Building Construction and Servicing.
Contractual Procedure.
Precision machine shop management.
Experience in Heavy Chemical Industry.

SALARY : Main Grade—£1130-£1435.
Basic Grade—£728-£1130.

Contributory Superannuation Scheme. Married Officers now living outside the Establishment's transport area will be eligible for housing on one of the Authority's estates; alternatively assistance towards legal expenses incurred in house purchase will be available. Until housed a lodging allowance may be payable.

Requests for application forms by POSTCARD to SENIOR RECRUITMENT OFFICER at the above address. Quote reference 850/26. J 747

CENTRAL ELECTRICITY AUTHORITY require a **FOURTH ASSISTANT ENGINEER INSTRUCTOR AT LINESMENS TRAINING SCHOOL** at EAST HORSLEY, SURREY. Candidates must be familiar with up-to-date methods of erection of 132-kV transmission towers, stringing and line maintenance and able to instruct personnel. Salary within Grade 4 N.J.B. £675-£850 p.a. Applications stating age, qualifications and experience to D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, not later than 15th January, 1956. Quote ref. AE/725. J 739

ENGINEERING ASSISTANT required by the GOVERNMENT OF FIJI P.W.D. for one tour of three years on contract in the first instance. Salary scale equivalent to £675 rising to £991 a year. Gratuity payable on satisfactory completion of contract. Free passages. Liberal leave on full salary. Candidates, preferably single, should have good experience in the design and construction of general Civil Engineering works with particular reference to the Survey and setting out of work, Drawing office practice, and Road Works. Write to the CROWN AGENTS, 4, MILLBANK, LONDON, S.W.1. State age, name in block letters full qualifications and experience and quote M2B/41374/E1. J 735

MINISTRY OF SUPPLY requires **MECHANICAL ENGINEERS** at Armament Research and Development Establishment near Sevenoaks, Kent, for guided weapons research and development. Knowledge of applied mechanics, strength of materials or metallurgy an advantage. Applicants who have 1st or 2nd class Honours degree will be considered for **SCIENTIFIC OFFICER** class, those with lower qualifications, e.g. Pass degree, H.N.C., etc., with minimum of Higher School Certificate (Science) or equivalent, for **EXPERIMENTAL OFFICER** class. Salaries according to age, experience, etc., in ranges: SENIOR SCIENTIFIC OFFICER (min. age 26), £1030-£1185, SCIENTIFIC OFFICER (min. age 21), £488 10s.-£885 (Superannuable), EXPERIMENTAL OFFICER (min. age 26), £745-£920, ASSISTANT EXPERIMENTAL OFFICER, £306 10s. (age 18)-£670. Women's salary subject to equal pay scheme. At least 3 years' post-graduate research experience required for the S.S.O. grade.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C.927/5A/QE, closing date, 20th January, 1956. J 813

MINISTRY OF FUEL AND POWER require **SENIOR EXPERIMENTAL OFFICER** for Technical Information Section, London. Salary—male £1125-£1325, female £995-£1155, with Equal Pay increases. QUALIFICATIONS: Science graduate, sound knowledge of Technical French and German essential and knowledge of fuel and power industries preferred. DUTIES include abstracting and translating scientific and technical papers and preparing bibliographies, monographs and technical briefs.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting F.923/5A. Closing date, 28th January, 1956. J 814

CIVIL ENGINEERS IN GOVERNMENT DEPARTMENTS. THE CIVIL SERVICE COMMISSIONERS invite applications for pensionable posts.

Age: at least 25 and under 35 on 1st January, 1955, with extension for regular service in H.M. Forces and, up to two years, for permanent civil service. Candidates must be Corporate Members of the Institution of Civil Engineers or have passed or been exempted from Sections A and B (now Sections I and II).

London salary scale (men), £705 (at age 25) to £1095. (Somewhat lower in provinces.) Starting salary according to age up to £970 at 34. Prospects of promotion. Salaries of next higher grades are £1095-£1415 and £1470-£1595. Women's salaries lower but being improved under equal pay scheme.

Further particulars and application forms from CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, 30, OLD BURLINGTON STREET, LONDON, W.1, quoting No. S64-66/55. Completed applications should be returned as soon as possible and in any case not later than 31st March, 1956. J 812

UNIVERSITY OF LONDON.

The Senate invite applications for the **READERSHIP IN MECHANICAL ENGINEERING** tenable at the Imperial College of Science and Technology (salary, £1300-£1550-£1800 a year).—Applications (10 copies) must be received not later than February 14, 1956, by the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1, from whom further particulars may be obtained. J 786

UNIVERSITY OF LONDON.

The Senate invite applications for the **READERSHIP IN AERONAUTICS** tenable at the Imperial College of Science and Technology (salary, £1300-£1550-£1800 a year).—Applications (10 copies) must be received not later than February 16, 1956, by the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1, from whom further particulars may be obtained. J 787

MIDDLESEX COUNTY COUNCIL
EDUCATION COMMITTEE.

HENDON TECHNICAL COLLEGE,
THE BURROUGHS, HENDON, N.W.4.

DEPARTMENT OF ENGINEERING.

Required,

UNIVERSITY GRADUATE with appropriate teaching and industrial experience as Senior Lecturer in Mechanical Engineering. Main subject Theory of Machines to post H.N.C. level.

Salary in accordance with the Burnham (Technical) Report £1065 by £25 to £1215 plus London Allowance.

Application forms (stamped addressed foolscap envelope) from the CLERK TO THE GOVERNING BODY, TOWN HALL, HENDON, N.W.4, to whom completed forms should be returned within fourteen days of the appearance of this advertisement.

C. E. GURR, M.Sc., Ph.D.,
SECRETARY TO THE EDUCATION COMMITTEE. J 751

THE INSTITUTION OF CIVIL ENGINEERS.

Applications are invited from **GRADUATES** and those expecting to graduate this year, for Rockefeller Bursaries for post-graduate and research in Public Health Engineering.—Full details are obtainable from The Secretary of the INSTITUTION, GREAT GEORGE STREET, LONDON, S.W.1. Applications must be received by 31st March, 1956. J 746

ADMIRALTY.
ROYAL NAVAL SCIENTIFIC SERVICE.

ENGINEERS AND PHYSICISTS (PARTICULARLY WITH ELECTRONICS) required in Experimental Officer and Assistant Experimental Officer grades in Experimental Establishments in London, Portsmouth, Weymouth areas, Gloucestershire and Scotland. Qualifications: British subjects, minimum of H.S.C. (Pass degree, H.N.C. or near equivalent an advantage). London salary (men), E.O. £790-£960, A.E.O. £320 10s.-£700 (according to age). Appointments unestablished but opportunities to compete for established posts.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A214/5A. J 724

LONDON COUNTY COUNCIL.

ARCHITECT'S DEPARTMENT.

Vacancies for **ENGINEERING ASSISTANTS** (up to £783) and Engineer Grade III (up to £945) in the Structural Engineering Division. Work includes steelwork and reinforced-concrete design and detailing for Council's buildings. Particulars and application forms from Architect (AR/EK/SE/1), THE COUNTY HALL, S.E.1. (1273). G 573

UNIVERSITY OF LONDON.

The Senate invite applications for the **CHAIR OF ELECTRICAL ENGINEERING** tenable at Queen Mary College (salary not less than £2100 a year). Applications (10 copies) must be received not later than February 13, 1956, by the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1, from whom further particulars may be obtained. J 785

NORTH THAMES GAS BOARD.

SENIOR DRAUGHTSMEN are required in the Chief Engineer's Drawing Office at Westminster, S.W.1, for the design and layout of general process plant and all associated structural steelwork.

Candidates should preferably be corporate Members of the Institutions of Structural or Mechanical Engineers. Starting salaries within the range £790 to £940 per annum, according to age, qualifications and experience. The successful candidates will be required to join the Staff Pension Scheme.

Applications, giving age and full particulars, should be sent to the STAFF CONTROLLER, NORTH THAMES GAS BOARD, 30, KENSINGTON CHURCH STREET, LONDON, W.8, quoting reference 666/314. J 731

CENTRAL ELECTRICITY AUTHORITY HEADQUARTERS.

SENIOR ENGINEERING DRAUGHTSMEN
and
ENGINEERING DRAUGHTSMEN

required in the Electrical, Civil and Mechanical Sections, Chief Engineer's Department, Bankside House, Sumner Street, London, S.E.1.

ELECTRICAL SENIOR DRAUGHTSMEN must be experienced in preparation of schematic diagrams and/or layout of 132-kV and 275-kV Grid substations and should also have some experience in supervising work.

DRAUGHTSMEN should preferably have experience on outdoor substations or in preparation of schematic diagrams.

CIVIL SENIOR DRAUGHTSMEN must have design experience preferably in Reinforced Concrete work and piled foundations.

DRAUGHTSMEN should have experience on Building details and/or R.C. work.

MECHANICAL SENIOR DRAUGHTSMEN AND DRAUGHTSMEN should preferably have experience in Generating Station layout or with a manufacturer of Generating Station plant and equipment.

Salaries are :—

Senior Draughtsmen, Grade 5, £672 by £21 to £777 p.a.
Draughtsmen, Grade 6, £536 by £21 to £662 p.a.

Opportunities will be given to Draughtsmen to obtain design experience with prospects of promotion to Senior Grade.

Canteen. One Saturday morning in four on duty. Permanent pensionable appointments.

Application forms obtainable from D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1. Quote ref. AE/726. J 806

BRITISH RAILWAYS,

CHIEF CIVIL ENGINEER'S OFFICE,
WESTERN REGION, PADDINGTON STATION, LONDON, W.2.

SENIOR ENGINEERING ASSISTANT experienced in design of R.C. and prestressed concrete bridges, competent to take charge in Drawing Office. Post offers permanency, opportunities for promotion and carries superannuation and rail travel privileges.—Apply giving age, experience and qualifications to CHIEF CIVIL ENGINEER. J 687

DERBYSHIRE EDUCATION COMMITTEE.

CHESTERFIELD COLLEGE OF TECHNOLOGY.
Principal: E. CARDWELL, M.Sc.(Lond.), Wh.Ex., M.I.Mech.E.

Applications are invited for the appointment of **LECTURER IN PRODUCTION ENGINEERING.** Duties to commence as soon as possible. Candidates should be graduates and/or corporate members of a professional institution and must have good industrial experience.

Salary in accordance with Burnham Technical Scale for Lecturers (£965 by £25 to £1065). Further particulars and forms of application from the undersigned (stamped addressed foolscap envelope required) to whom applications should be returned by 20th January, 1956.

S. A. BROADWELL,
Registrar.

College of Technology,
Infirmary Road,
Chesterfield. J 760

NORTHAMPTON POLYTECHNIC,
LONDON, E.C.1.

GRADE B LECTURERS required for full-time permanent pensionable staff to instruct students in INSTRUMENT ENGINEERING. Candidates should possess B.Sc., H.N.C. or equivalent and have wide industrial experience in Instrument Making, and Instrumentation. A knowledge of Automatic Control would be an advantage. Salary on Burnham Scale: £561 by £25 to £868, with £60 for graduate or equivalent professional qualification and £18 to £54 for university training. Allowance is made for industrial or teaching experience in determining commencing salary. Excellent opportunity in expanding Department for entering the Technical Teaching Profession with prospects of reaching a salary over £1100 p.a.—Apply for form to SECRETARY. J 761

THE UNIVERSITY OF LIVERPOOL.

FACULTY OF ENGINEERING.

Applications are invited from graduates for a **MUNITIONS COMMITTEE FELLOWSHIP,** tenable for one year and renewable for a second year, at an annual value of £350. Applications, stating age, academic qualifications and experience, together with the proposed subject of research and the names of three referees, should be received not later than 1st March, 1956, by the undersigned, from whom further particulars of the conditions of award may be obtained.

STANLEY DUMBELL,
Registrar. J 773

ELECTRIC
melting and smelting
PRACTICE

By A. G. E. ROBIETTE, M.Sc., F.I.M.

Arc furnaces for steel-making — for iron melting — for non-ferrous metals. Normal frequency / channel type induction furnaces. High-frequency / coreless induction furnaces. Resistor furnaces. Electric pig-iron smelting. Ferro-alloy smelting. Electric smelting of non-ferrous metals.

348 pages. Very fully illustrated. Price 50s. net.

CHARLES GRIFFIN & COMPANY LIMITED
42 DRURY LANE LONDON W.C.2

Classified Advertisements continued on Page 4

TECHNICIAN (MAIN GRADE) required by the ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS, to control and supervise a workshop engaged on small batch production of a specialist nature, including precision machining of special materials (e.g. radioactive and toxic), involving unusual techniques. Applicants should have served a recognised engineering apprenticeship and have previous experience in the control of skilled labour. They should be used to precision machining and fitting work and be capable of following and adopting new machining techniques. Possession of O.N.C. or equivalent qualification would be an advantage.

SALARY: £743 (linked to age 30)-£873 p.a. Contributory Superannuation Scheme.

Married officers now living outside the Establishment's transport area will be eligible for housing on one of the Authority's estates, alternatively assistance towards legal expenses incurred in house purchase will be available; until housed a lodging allowance may be payable.

Requests for application forms by POSTCARD to the SENIOR RECRUITMENT OFFICER at the above address. Quote reference A775/26. J 776

TECHNICIANS (BASIC GRADE) required by the ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS, as assistants in the Metrology and Inspection Departments of the Establishment. The duties are concerned with the high precision measurement of interesting prototype work. Applicants should have served a general engineering apprenticeship or have exempting qualifications and must be prepared to use considerable initiative in devising their own methods of measurement as the work is generally unorthodox and intricate. Possession of O.N.C. or equivalent qualifications would be an advantage. A sound knowledge of engineering principles as applied to the use of modern and specialised measuring equipment is essential.

SALARY: £608 (linked to age 26)-£748 p.a. Contributory Superannuation Scheme.

Married officers now living outside the Establishment's transport area will be eligible for housing on one of the Authority's estates, alternatively assistance towards legal expenses incurred in house purchase will be available; until housed a lodging allowance may be payable.

Requests for application forms by POSTCARD to the SENIOR RECRUITMENT OFFICER at the above address. Quote reference A750/26. J 777

ADEN PORT TRUST.

The Board of Trustees of the Port of Aden invite applications for a post of

ASSISTANT WORKSHOP SUPERINTENDENT ELECTRICAL. Applicants should be not more than 36 years of age with considerable experience of electrical wiring A.C. motors and A.C. Workshop and Wharf Installations, also Mechanical and Workshop experience. He must be familiar with I.E.E. regulations and able to satisfy the Electrical Inspector Aden of his competency as an Electrical Supervisor.

SALARY SCALE:

(*a*) For Higher qualifications such as A.M.I.E.E. or equivalent, £1300 by £50 to £1700 p.a.

(*b*) If applicant does not possess the above qualification, £1200 by £50 to £1500 until he has acquired it.

Free unfurnished quarters are provided and free medical attention for the employee. A contributory medical benefit scheme covers dependants for a small charge.

Option is available to enter the service on short term contract for five years, comprising two tours, each two years abroad, followed by six months' leave, with a gratuity of 10 per cent. of final annual salary for each year of service, or alternatively joining the Permanent Service on probation.

Option is also given of entering the Permanent Service of the Board subject to the Board's approval at the end of the five years' contract.

Application forms and full details may be obtained from THE CONSULTING ENGINEERS AND AGENTS, ADEN PORT TRUST, 1, LYGON PLACE, LONDON, S.W.1. J 835

THE ELECTRICITY CORPORATION OF NIGERIA.

JUNIOR CIVIL ENGINEERS.

The Electricity Corporation of Nigeria has vacancies for two Junior Civil Engineers to work mainly on water power investigations and development. They will be required to carry out hydrological and topographical surveys in isolated localities and must therefore be willing to spend a considerable period of time in " bush " country. It is emphasised that only those who have a genuine enthusiasm for this type of work and are able to adapt themselves to the local conditions need apply for the post.

Qualifications required :

(1) Degree in civil engineering.

(2) Field experience in tacheometric surveying is essential.

(3) Preferably some experience of river gauging by use of current meter or an adequate knowledge of hydraulic principles.

(4) Owing to the nature of the work, preference will be given to unmarried candidates or to married men who are prepared to leave their wives and families in U.K. for the whole term of service.

The commencing basic salary will be within the range of £1125 to £1232 per annum plus an Inducement Allowance of £300 per annum. Contract terms (non-pensionable) at 10 per cent. per annum additional to the basic rate, plus a gratuity at the rate of £37 10s. for each completed three months of service, payable upon termination of engagement. A further allowance of £10 per month is paid whilst working in the field.

Rent deductions will not be made from officer's salary during the period that he is working under field conditions.

Appointments will be on a one tour basis in the first case with prospects of transfer to the permanent and pensionable staff. The conditions governing length of tours, amount of leave, payments of passages, children's allowance, rents, gratuity, etc., are those which apply to the Electricity Corporation of Nigeria and may be obtained from this office.

ELECTRICITY CORPORATION OF NIGERIA,
11, MANCHESTER SQUARE,
LONDON, W.1. J 839

BOROUGH OF MORECAMBE AND HEYSHAM.

£2 MILLION SEWERAGE SCHEME.

APPOINTMENT OF TEMPORARY ENGINEERING ASSISTANT.

Applications are invited for the post of Temporary Engineering Assistant (probable duration of post not less than 18 months to 2 years) on the Corporation's new major sewerage scheme. The post offers a unique opportunity of obtaining valuable experience on one of the largest sewerage projects in the country. Salary £650 per annum plus £2 2s. per week subsistence allowance.

Applications, setting out details of age, qualifications and experience, should reach me by 20th January, 1956.

ROGER ROSE,
TOWN CLERK.

Town Hall,
MORECAMBE AND HEYSHAM. J 845

CAIRO UNIVERSITY.

FACULTY OF ENGINEERING.
GIZA—EGYPT.

Applications are invited for the post of **PROFESSOR OF HEAT ENGINES AT THE FACULTY OF ENGINEERING, CAIRO UNIVERSITY, EGYPT.**

Candidates should be capable of delivering lectures in English.

Appointment shall be by contract for two calendar years, renewable thereafter for five years, if desired. Salary offered from £E.900 to £E.1500 basic, plus £E.360 expatriation allowance and £E.75 high cost of living allowance per annum. Higher basic salaries may be considered in cases of outstanding qualifications.

Full particulars of age, academic qualifications, engineering and teaching experience, recent scientific and engineering contributions and publication should reach the Dean of the Faculty by registered mail before 1st FEBRUARY, 1956. J 844

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

Required by THE AVON INDIA RUBBER CO., MELKSHAM, WILTS., one **SENIOR ENGINEERING DRAUGHTSMAN.** H.N.C. standard desirable and should be experienced in general engineering work, factory layouts and, if possible, special-purpose equipment design. Attractive salary paid for the right man.—Reply to the CHIEF ENGINEER. J 820

GUIDED MISSILES DIVISION
of
THE ENGLISH ELECTRIC CO.,
STEVENAGE.

A vacancy exists in the Electronics Department for a **MECHANICAL DESIGNER** to lead a group engaged on the mechanical design of electronic and small electro-mechanical equipments to A.I.D. standards for Service use.

Applicants should have had at least three years in a similar position and preferably should be qualified engineers, and be fully conversant with Ministry Design specifications such as K.114, R.G.S.1000, etc. They should have a basic knowledge of electronics and experience of mobile installations, experience of liaison with Drawing Offices would be an advantage. The salary will be in accordance with previous experience and training. Housing assistance available.—Apply to DEPT. C.P.S., 336/7, STRAND, W.C.2, quoting Ref. 1424. J 825

Consulting Engineers, Westminster, require **ASSISTANT** experienced in the design and/or detailing of reinforced concrete bridges. High salary, interesting work and excellent prospects. Write stating age, qualifications and full details of experience.—BOX J 822, Offices of ENGINEERING.

TWO JUNIOR ENGINEERING DRAUGHTSMEN required by THE AVON INDIA RUBBER CO., MELKSHAM. Age approximately 21-24, and must have completed National Service. Preferably of O.N.C. standard and studying for H.N.C. This is a good opportunity for young men to carve themselves out an interesting and progressive career with an expanding Company in a Department handling a wide variety of Engineering work.—Reply to the CHIEF ENGINEER. J 821

ENGINEER required for managerial appointment with a large industrial undertaking in the N.W. The work is interesting and varied and entails control of Estimators, Drawing Office, and Site Supervisory Staff for factory layouts, and plant and services installation. An electrical engineer who has served a works apprenticeship and has some knowledge of mechanical engineering would be preferred. Minimum qualification is Corporate Membership I.E.E. or I.Mech.E. Age limits, 35-45. Please state, in confidence, full details of training and experience, age and salary required. The post is a senior one carrying a salary commensurate with the responsibility involved; a contributory pension scheme is in operation.—BOX J 848, Offices of ENGINEERING.

Engineering Vacancies with the

BRITISH OXYGEN ENGINEERING LTD

AVIATION DIVISION

Applications are invited for the following appointments with the newly formed Aviation Division of the British Oxygen Engineering Limited offering excellent opportunities in a new field for Engineers with ability and initiative.

★

Senior Development Engineers

A degree in Engineering or Science and/or Corporate Membership of an appropriate Institute is essential. Applicants must have had experience in the Aircraft Precision Equipment field, preferably in hydraulics, pneumatics or cabin and personal equipment used by Air Crew. A lively and enthusiastic approach to development problems is required and applicants must have had experience as a Leader or Deputy Leader of a Development Team and be capable of carrying a Design Study through all phases.

Development Engineers

Preferably with a degree in Engineering or Science, but candidates who possess H.N.C. and are Graduate Members of an appropriate Institute will be considered. General experience should be similar to the senior post above, and applicants must have been members of a Design or Development Team and be capable of advancement.

Chief Inspection and Test Engineer

Experience in the Aircraft Precision Equipment field is essential, including A.I.D. and A.R.B., with ability to formulate Inspection and Test requirements in conjunction with Design Department and to organize and control Inspection and Test procedures. Applicants should have had at least five years' experience in an associated field, preferably latterly, in an executive or supervisory capacity.

Planning Engineers

Applicants must be fully conversant with modern light and medium machine shop practice as applied to quantity and batch production from ferrous and non-ferrous metals. Some knowledge of rate fixing is essential and experience of assembly work is desirable.

Technical Assistants

Applicants are invited from new graduates or persons with H.N.C. who are interested in development work related to the Aircraft Equipment field. Candidates must be capable of writing clear and lucid reports and drawing ability will be an advantage.

Technical Writer

Applications are invited from persons with experience in the Aircraft Industry and in producing technical reports from data provided. Candidates must be capable of leading a small team in due course.

Senior Jig and Tool Draughtsmen

Applicants must have had first-class experience as related to light/medium machine shop work and light assembly fixtures.

★

The Company offers EXCELLENT SALARIES and prospects of ADVANCEMENT together with ideal welfare facilities, including a PENSION FUND.

THE AVIATION DIVISION WILL BE LOCATED AT THE COMPANY'S NEW FACTORY AT HARLOW, ESSEX, WHERE RENTED HOUSING ACCOMMODATION IS AVAILABLE. REMOVAL EXPENSES WILL BE PAID.

★ Applications, giving full details of qualifications, experience, present salary and salary required, to the Staff Officer, British Oxygen Engineering Limited, Angel Road, Edmonton, N.18.

J 757

DESIGNERS and DRAUGHTSMEN required by
BRITISH OXYGEN ENGINEERING
LIMITED (PLANT DIVISION)
AT EDMONTON AND HARLOW

Excellent opportunities are offered to Designers and Draughtsmen with good qualifications and experience in one or other of the following:

★ Pressure Vessels ★ Pumps and Compressors
★ Pipework ★ Chemical Plant
★ General Mechanical Engineering

The Company offers EXCELLENT SALARIES and prospects of ADVANCEMENT together with ideal welfare facilities, including a PENSION FUND.

APPOINTMENTS FOR DESIGNERS AND DRAUGHTSMEN WILL BE MADE AT THE COMPANY'S OFFICES AT EDMONTON OR HARLOW. AT HARLOW RENTED ACCOMMODATION IS AVAILABLE AND REMOVAL EXPENSES ARE PAID. AT EDMONTON, HOUSE PURCHASE FACILITIES ARE AVAILABLE AND REMOVAL AND LEGAL EXPENSES ARE PAID.

Applications, giving full details of qualifications, experience, present salary and salary required, to the Staff Officer, British Oxygen Engineering Limited, Angel Road, Edmonton, London, N.18. J 748

SENIOR AND JUNIOR MECHANICAL AND GENERAL DRAUGHTSMEN

required for

IRON & STEELWORKS ORGANISATION ON NORTH-EAST COAST

Heavy or medium engineering experience desirable but not essential. Vacancies exist both in main and works drawing offices, and can prove progressive to those showing aptitude for advancement. Technical knowledge preferably to H.N.C. standard or higher.

Hours of work are nominally 38 per week with payment for overtime and a Contributory Superannuation Scheme is in operation.

Temporary flat accommodation is available at a moderate rental to successful early applicants, and assistance may be given in respect of removal expenses.

Apply stating age, experience, standard of technical knowledge and salary expected to BOX J 708, Offices of ENGINEERING.

DOWTY EQUIPMENT LIMITED require **HYDRAULIC PUMP DESIGNER.** Should have aircraft experience and preferably University Degree. A.F.R.Ae.S. qualifications an advantage. Executive status for successful applicant.—Write to the PERSONNEL MANAGER, ARLE COURT, CHELTENHAM SPA, GLOS. J 672

QUANTITY SURVEYOR required by Consulting Engineers in Birmingham. Staff pension scheme. Please reply in confidence giving qualifications, previous experience, age, etc., to BOX No. 295, GLOVERS ADVERTISING LIMITED, 351, OXFORD STREET, LONDON, W.1. G 595

West End London Consulting Engineers require now **SEVERAL SENIOR AND JUNIOR ENGINEER DRAUGHTSMEN** to prepare designs, contract drawings, specifications, etc., for heating, ventilating, boiler plant and allied mechanical services. Interesting work for factories, office blocks, hospitals, colleges, schools, etc. Opportunity for experienced men with initiative. Five-day week. One week's spring holiday in addition to usual summer two weeks. Bonus and optional superannuation scheme.—Write stating age, experience, qualifications and salary required. BOX G 538, Offices of ENGINEERING.

Large engineering group in the north-east is now establishing a development section with the object of developing new products in the mechanical engineering field, covering prime movers, heat exchangers and ancillary equipment.

Good opportunities are available for **SUITABLY TRAINED ENGINEERS** of degree or H.N.C. standard. Salary depending on qualifications and experience; pension scheme; five-day week.

Apply BOX J 717, Offices of ENGINEERING.

BRITISH MERCHANT FIRM IN MALAYA with established Engineering Department, holding exclusive agencies for leading British makers of excavators and other mechanical plant also electrical plant, has vacancy for an **ENGINEER** on the sales side, age 22-25 and single. Candidate should have either a Degree or Higher National Certificate.

Liberal salary, etc., terms, including free furnished quarters and car allowance. Interview London.—Write with full particulars of education and experience to BOX T.680, c/o STREET'S, 110, OLD BROAD STREET, E.C.2. J 704

CIVIL AND STRUCTURAL ENGINEERING DESIGNER AND DRAUGHTSMEN AND STRUCTURAL CHECKERS required for Consultants Offices in Bristol and elsewhere in England and Wales. Must be experienced in one or more of the following:—Structural Steelwork for buildings and material handling plants, reinforced concrete pipework and general building construction.

Five-day week, pension scheme and good salaries and opportunities for promotion by merit.

Reply stating age, experience and qualifications.—BOX J 651, Offices of ENGINEERING.

ENGINEERS.

Applications are invited from qualified **MECHANICAL ENGINEERS (PREFERABLY A.M.I.MECH.E.)** for a number of permanent and pensionable appointments at Fort Dunlop. Industrial experience of plant layout and mechanical handling systems is desirable; knowledge of Work Study techniques an advantage. These positions provide excellent scope for advancement in an expanding Company with world-wide interests.—Please write, giving age, qualifications, experience and salary required to the PERSONNEL MANAGER, DUNLOP RUBBER CO., LTD., FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24. J 709

ENGINEERS WHO ARE SEEKING POSITIONS IN INDUSTRY

offering breadth of experience, scope for advancement and good remuneration, with many attractive features of employment, should be acquainted with the possibilities offered by service in the CENTRAL ENGINEERING DEPARTMENT OF ALBRIGHT & WILSON LTD.

Based at Oldbury, the Department is responsible for the design, construction and commissioning of new plant at the British factories of the company and its associate, Midland Silicones Ltd. Close contact is maintained with the Research and Manufacturing Departments and with engineering development in the factories of the company and its associates overseas.

Experience of plant operation is obtained through commissioning and process investigation. Opportunities frequently occur for promotion within the Department or to the Management and Engineering Staffs of the company's factories.

With a continuing programme of expansion the following vacancies exist and a brief indication of requirements is given :—

(*a*) **SENIOR CHEMICAL ENGINEERS** to lead project teams and to maintain liaison with engineering contractors. Degree and 5-10 years' experience of plant design and chemical manufacture.

(*b*) **CHEMICAL ENGINEERS** for design teams, project study and evaluation, plant investigation and commissioning. Degree and 2-5 years' experience in chemical or allied industry.

(*c*) **MECHANICAL ENGINEERS** for project teams, liaison with engineering contractors and work in connection with factory services and mechanical handling. Degree and 3-10 years' experience of design and operation of process plant.

(*d*) **A STANDARDS ENGINEER** to be responsible to the Chief Engineer for the development of company engineering standards and co-operation with national standardizing bodies.
Degree or H.N.C. in Mechanical Engineering, at least 10 years' experience in industry and ability to ensure co-operation of Works Engineering and Design Staffs.

(*e*) **AN INSTRUMENT ENGINEER** to work under the Chief Instrument Engineer on the application of automatic control and the solution of special instrument problems.
Degree in mechanical or electrical engineering with several years' experience of industrial instrumentation.

(*f*) **AN ELECTRICAL ENGINEER** for planning and supervision of installation of industrial power and lighting systems.
Degree and 3-5 years' experience of industrial distribution, switchgear and motors.

(*g*) **DESIGNERS** responsible to the Chief Draughtsman for projects in the drawing office, supervision detailed design and drawing work, preparing specifications and checking tenders.
Degree or H.N.C. in mechanical engineering with about 5 years' experience of plant maintenance in the chemical or allied industries.

(*h*) **DRAUGHTSMEN,** senior and junior, for layout and detail work on a wide variety of equipment including mechanical, structural, piping and civil engineering and for estimating.
O.N.C. or H.N.C. with apprenticeship and drawing office experience.

For posts (*b*), (*c*), (*e*) and (*f*) men graduating in 1956, or completing National Service after graduating previously, will be considered.

The appointments carry membership of a non-contributory pension scheme.

For information regarding the work of the Department and the Duties involved in the above positions, write to the CHIEF ENGINEER, ALBRIGHT & WILSON LTD., CHEMICAL MANUFACTURERS, P.O. BOX No. 3, OLDBURY, BIRMINGHAM. J 781

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ASTE DIE DESIGN HANDBOOK

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Sponsored by the American Society of Tool Engineers

An outstanding collection for the die designer and die user, containing hundreds of tested practical designs for every class of cold pressworking. It includes the newest methods for forming titanium, zirconium and tantalum, for cold extrusion of steel, and for hydraulic-action and rubber-action forming.

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ASSISTANT ENGINEER required in London Office of Consulting Engineers for contract and engineering work on generating plant for hydro-electric power stations. Previous experience on this class of work not essential but starting salary according to qualifications with good prospects for advancement. Apply KENNEDY & DONKIN, 12, CAXTON STREET, S.W.1, quoting reference HH. J 618

WANTED

DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO. LTD., BUSH HOUSE, ALDWYCH, LONDON, W.C.2. G 562

DETAIL DRAUGHTSMAN required, O.N.C. preferred, for interesting electro-mechanical equipment for use on ships. Absorbing work with good prospects of advancement for a man with initiative. State age, qualifications, experience, salary required, and if possible send sample of drawing work with application to MR. E. R. BROOKE, NAVAL DRAWING OFFICE, EVERSHED & VIGNOLES, LIMITED, ACTON LANE WORKS, CHISWICK, LONDON, W.4. J 689

SULZER BROS. (LONDON), LTD., require **SENIOR AND JUNIOR DIESEL ENGINEERS** for Rail Traction Department. Sound technical background and qualifications essential. Good salary commensurate with experience.—Write giving full details including present salary to SECRETARY, 31, BEDFORD SQUARE, LONDON, W.C.1. J 701

Classified Advertisements continued on Page 6

MECHANICAL ENGINEERS

Vacancies exist with the UNITED KINGDOM ATOMIC ENERGY AUTHORITY for MECHANICAL ENGINEERS at the INDUSTRIAL GROUP HEADQUARTERS, RISLEY, NR. WARRINGTON.

DUTIES: To take charge of a section in the Mechanical Plant Design Office to deal with the design and specification of a wide range of service plant including compressors and compressed air installations, lifting and mechanical handling plant, machine tools and workshop layout.

QUALIFICATIONS AND EXPERIENCE: Applicants must have served a recognised engineering apprenticeship and be corporate members of the Institution of Mechanical Engineers, or have equivalent qualifications.

SALARY: £1130 rising by annual increments of approximately £40 to £1435 per annum. Successful candidates under 55 will be required to join the Authority's Contributory Pension Scheme, which includes widows' and dependants' benefits.

Suitably qualified persons are invited to send a post-card quoting reference 1228, to the RECRUITMENT OFFICER, U.K.A.E.A., INDUSTRIAL GROUP HEADQUARTERS, RISLEY, NR. WARRINGTON, LANCS. Closing date, 13th January, 1956. J 738

DRAUGHTSMEN, SENIOR AND JUNIOR, required by a progressive Engineering firm making special-purpose labour saving plant in great demand. Top rates and excellent opportunity for competent men.—BOX J 766, Offices of ENGINEERING.

RUSTON-BUCYRUS LTD.

Excavator Specialists

invite applications from qualified engineers for appointment as

PRODUCTION MANAGER.

Basic requirements are University Degree in Engineering or Corporate Membership of one of the Professional Institutions plus practical knowledge of modern production systems, the latter is particularly important. This is an interesting and high level appointment in a modern and fully equipped works in the medium/heavy engineering industry.

Interested applicants should write in first instance giving age and all relevant particulars including approximate salary required, to:

PERSONNEL MANAGER,
RUSTON - BUCYRUS LTD.,
EXCAVATOR WORKS,
LINCOLN.

J 763

ARMSTRONG SIDDELEY MOTORS have vacancies for both

SENIOR AND JUNIOR ENGINEERS

for investigation of vibration problems on gas turbine development engines. Degree or H.N.C. in Mechanical Engineering or Electrical Engineering essential. Electrical Engineers should have some mechanical engineering experience. Applicants must be capable of using necessary recording equipment. Salaries commensurate with qualifications and experience, together with good pension scheme. —Applications to REFERENCE CG/VP, TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 621

ENGINEER FOR WEST AFRICA for the operation and maintenance of Vegetable oil producing factory. Candidates must be of good education; preferably at least G.I.Mech.E. or equivalent; age 26 to 33; experienced in plant maintenance. A good practical experience of Steam Boilers and engines is essential preferably including knowledge of centrifuges, diesel engines and small electrical installations. The post is one of responsibility for efficient processing, control of staff, training of Africans and may include upkeep of transport vehicles.

Commencing salary not less than £1000 per annum. In addition there are family allowances, free furnished accommodation and medical attention provided in Africa. Membership of Pension fund. Tours of about 21 months with leave on full pay. Free first class passages including family.

Apply giving details of education, qualifications and experience to BOX J 736, Offices of ENGINEERING.

DESIGN DRAUGHTSMEN.

THE BRITISH DRUG HOUSES LTD. invite applications from suitably qualified men for interesting work in their Engineer's Drawing Office, on special machines and plant layouts for the Light Chemical Industry. Higher National Certificate in Mechanical Engineering and previous experience in this industry desirable but not essential. Men of mature age with suitable training and experience would be considered. Five-day week. Pension and Profit Sharing Schemes.—Write, stating age, experience and salary required, to STAFF MANAGER (REF. B8912), GRAHAM STREET, CITY ROAD, N.1. J 792

STRUCTURAL DESIGNER required for busy London Office handling a wide variety of building schemes. Considerable scope for advancement is available to a reliable man with initiative who can work with minimum supervision and deal with site matters.—BOX J 753, Offices of ENGINEERING.

Leading firm of Management Consultants requires for its Canadian Subsidiary

MECHANICAL ENGINEERS AND ELECTRICAL ENGINEERS with managerial experience of production on a considerable scale. Permanent appointments in Canada on high scale salary after preliminary period in this country. Age 30 to 38 years. University degree or equivalent qualification.—Apply with full details to BOX J 730, Offices of ENGINEERING.

DETAIL DRAUGHTSMEN, JIG AND TOOL DESIGNER DRAUGHTSMEN AND PROCESS PLANNING ENGINEERS required at the UXBRIDGE FACTORY OF BELL PUNCH CO., LTD., manufacturers of the well-known Sunlock calculating machines, ticket issuing machines, taximeters, etc. Applicants should preferably be of National Certificate standard and have served an apprenticeship in mechanical engineering. Good salaries and excellent conditions in modern drawing offices with opportunities for further advancement. Good social facilities and modern canteen.—Apply in writing or personally to PERSONNEL DEPARTMENT any day, Monday to Friday, between 9.30 a.m. and 11 a.m. or 2 p.m. to 4 p.m. J 743

EXPERIENCED DRAUGHTSMEN for Detailing Structural Steelwork. Good salaries. Five-day week. Pension Scheme. Canteen facilities. State experience and age when applying to THE DIRECTORS, JOHN BOOTH & SONS (BOLTON), LTD., HULTON STEELWORKS, BOLTON. J 754

RESEARCH ENGINEER OR PHYSICIST

with advanced knowledge of thermodynamics required by a Glasgow Engineering Company. Applicants, aged 25-30, should have a University Honours Degree. Experience in heat transfer problems would be an advantage. Salary depending on qualifications and experience.—Apply to BOX G 583, Offices of ENGINEERING.

JOHN LAING AND SON LIMITED

invite applications for the following technical staff vacancies resulting from promotion and expansion at the Research and Development Centre, Boreham Wood, Herts.

CHIEF MECHANICAL DESIGN ENGINEER.

In charge of Mechanical and Electrical Design Department. Preferably Chartered Mechanical Engineer, and an additional electrical qualification desirable. Adequate general engineering experience with specific design work on medium heavy plant and equipment. Age 30-50. Considerable opportunity for original design in a very wide field, together with general consultative services to the Company and its subsidiaries. Applicants must be adaptable and ready to tackle a wide variety of problems.

SENIOR MECHANICAL DESIGN ENGINEERS.

Qualifications and experience similar to the above though less advanced. Age 28-50.

ASSISTANT DESIGN ENGINEERS AND DRAUGHTSMEN.

Experience of mechanical design and detailing is desirable, but applications will be welcomed from graduates and those seeking to qualify professionally. Age 21 upwards.

The above posts are on a permanent basis, and are progressive and pensionable. The work is varied and interesting and holds attractive prospects in an expanding field. Five-day week.

Canteen and Sports Club facilities.

Apply in writing stating age, qualifications, and salary expected, to:—PERSONNEL MANAGER (M.18), JOHN LAING & SON LIMITED, BUILDING AND CIVIL ENGINEERING CONTRACTORS, LONDON, N.W.7. J 765

DESIGNER DRAUGHTSMAN required immediately by BELL PUNCH CO. LTD., UXBRIDGE, for design and development of varied mechanical and electro-mechanical instruments, also equipment for office and cash control machines. Must possess ability to work from schematic sketches and produce complete drawings for prototype construction.—Apply by letter giving full details of age, experience, qualifications and salary required, to the PERSONNEL DEPARTMENT. J 744

A GRADUATE WITH AN ENGINEERING (MECHANICAL OR CHEMICAL) OR METALLURGICAL TRAINING is required as Assistant to the Manager of the KANIGEN division of Albright & Wilson, Ltd. Experience of corrosion and wear problems in a wide field of engineering is desirable. The post is in London and concerns Sales and Administration in an expanding division of the Company. Age 25-30. Non-contributory pension scheme. Commencing salary according to age, qualifications and experience.—Apply to the STAFF OFFICER, REF. NO. 270, ALBRIGHT AND WILSON, LTD., P.O. BOX 3, OLDBURY, BIRMINGHAM. J 780

A well-known Industrial Organisation with world-wide interests wishes to recruit

A YOUNG QUALIFIED MECHANICAL ENGINEER, AGE 23/30, for appointment as an Assistant Engineer within their Production Division. The successful applicant will become a member of a management team and should be capable of accepting a high degree of responsibility within 3-4 years. This is an attractive opportunity for the right man. The Organisation is expanding and its product is an interesting one.—Reply, stating full particulars of age, qualifications and experience, to BOX J 793, Offices of ENGINEERING.

DESIGNER-DRAUGHTSMEN

and

DETAIL DRAUGHTSMEN

With Crane or Structural Experience required by

COWANS, SHELDON & CO., LIMITED,

of Carlisle.

Good Commencing Salary and Pension Scheme. G 622

TURBINE TENDERING ENGINEER is required for the Turbine Division of Brush Electrical Engineering Co., Ltd. The position offers considerable scope for a man of ability and initiative. Applicants must have suitable technical qualifications and preferably experience in tendering for turbo-alternator plant. A good salary commensurate with qualifications and experience will be paid and there is in operation a non-contributory Pension Scheme. Applications should be addressed to :—

THE CHIEF PERSONNEL OFFICER,
BRUSH ELECTRICAL ENGINEERING CO., LTD.,
LOUGHBOROUGH, LEICS. J 796

ASSISTANT INSPECTING ENGINEERS (MECHANICAL), AGED 25-35, required in Manchester and Glasgow by Consulting Engineers to assist with inspection and testing supervision of mechanical plant. Applicants should possess I.Mech.E. qualifications or necessary exemptions and have had a sound engineering training, and should preferably have had material testing and general workshop inspection experience.—Please apply for application forms to "STAFF APPLICATIONS," KENNEDY & DONKIN, PARK HOUSE, 813a, WILMSLOW ROAD, DIDSBURY, MANCHESTER, 20. J 805

ENGINEER (AGE 25-35) required for Consulting Engineers' Office in Manchester; Technical qualifications should include a degree and/or corporate membership of a major engineering Institution; varied industrial experience an advantage. Technical and impartial reports following industrial accidents, commenting on safety of method of work, compliance with Statutory Regulations, etc.; giving evidence in High Court if litigation ensues.—BOX J 800, Offices of ENGINEERING.

ALFRED HOLT & CO. invite applications for the post of

CHIEF SUPERINTENDENT ENGINEER, which will become vacant in 1956. Sea-going experience is essential and an honours degree in marine or mechanical engineering or the equivalent in theoretical knowledge is desirable.—Applications should be addressed to ALFRED HOLT & CO., INDIA BUILDINGS, LIVERPOOL, 2, and the envelope marked "M/RSM." J 775

SENIOR JIG AND TOOL DRAUGHTSMAN required with experience in one or more of the following :—

General Engineering.
Mine Cars.
Tanks and Pressure Vessels (all codes).
Heavy Fabrication Work.

Permanent situations with good working conditions. Five-day (37½ hour) week, pension fund, housing available for suitable applicants.

Applications, stating age, experience, technical qualifications and salary required, to :—DISTINGTON ENGINEERING CO., LTD., P.O. BOX No. 8, WORKINGTON, CUMBERLAND. J 767

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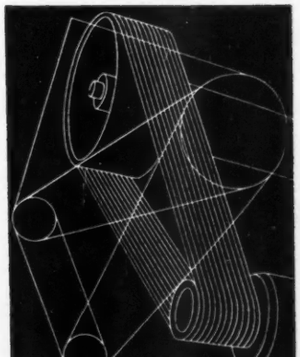

Smith's local shop or bookstall can quickly supply you with books on all aspects of engineering. Colleges and works librarians, in particular, are invited to ask for lists of titles on any technical subject. They will speedily be obtained by the W. H. Smith local branch.

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Head Office: STRAND HOUSE, LONDON, W.C.2

SHORT BROTHERS & HARLAND LIMITED, BELFAST

require a

WELDING ENGINEER

to develop techniques and processes for light alloys, stainless and high tensile steels, titanium, etc. Interesting programme of work for applicant with suitable experience, preferably on air-frame manufacture, together with general commercial welding. Position will carry Executive Staff status.

Assistance with housing and removal is available.

Write, stating age, and giving full particulars of education and technical experience, to :—

PERSONNEL MANAGER,
BOX 241,
BELFAST,

quoting Reference P.28. J 755

STEEL BUYING AGENTS with wide effective connections in this country, should contact well-known and expanding organisation.—BOX J 441, Offices of ENGINEERING.

JUNIOR DRAUGHTSMEN, having completed National Service, required for work on large chemical plant installations. A.E.S.D. minimum rates or above. Five-day week and superannuation scheme. —Apply by letter giving details of technical education to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 575

DIESEL DEVELOPMENT ENGINEERS

For new development work on Fuel Injection Equipment. Applicants should have degree in engineering or H.N.C., together with suitable experience in the diesel engine or commercial vehicle field.

SALARY UP TO £925 P.A.

Applications will also be considered from younger men for position of

ASSISTANT DIESEL DEVELOPMENT ENGINEERS

SALARY RANGE £550-£775 P.A.

Vacancies are permanent and pensionable and application should be sent to the Personnel Manager (Ref. D.L.).

C. A. V. LIMITED

WARPLE WAY, ACTON, W.3.

G 495

MECHANICAL AND STRUCTURAL DESIGNER/DRAUGHTSMEN, also competent Detailers, required by ASHMORE, BENSON, PEASE & CO., STOCKTON-ON-TEES. Must have sound knowledge application of mechanical or structural design for Gas, Chemical, Blast Furnace and similar plants.

Maximum assistance given in obtaining accommodation. Pension Scheme, Technical Library and sports facilities available.—Apply, stating age, experience, etc., quoting Ref. L/F, to STAFF PERSONNEL OFFICER. G 567

BRITISH PETROLEUM COMPANY LIMITED offers

STUDENT APPRENTICESHIPS IN MECHANICAL AND CHEMICAL ENGINEERING for men who have completed their period of National Service and who possess G.C.E. in five subjects of which Mathematics and/or Physics must have been passed at "A" level and English at "O" level. Age 19-22. The apprentices will attend a Technical College for a full-time Sandwich Course of Studies during their first six months and will then go to a Refinery for practical training. The Course is of 4 years duration.—Applications giving full details of education and experience should be addressed to MANAGER, RECRUITMENT BRANCH, quoting reference H.3570, to BOX 8347, c/o 191, GRESHAM HOUSE, E.C.2. G 608

MECHANICAL AND ELECTRICAL SERVICES ENGINEER required by Consulting Engineers in Birmingham. Permanent post with pension scheme.—Reply in confidence giving qualifications, previous experience, age, etc., to BOX No. 300, GLOVERS ADVERTISING LTD., 351, OXFORD STREET, LONDON, W.1. G 596

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential, applicants with general mechanical engineering experience will be favourably considered. The posts offer excellent opportunities with generous salaries commensurate with experience and ability. Offices situated in the N.W.1 London area. Five-day week and superannuation scheme.—Applications, which will be treated in confidence, should give previous experience and qualifications and be addressed to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 576

A well-known Organisation wishes to interview

YOUNG MEN who would eventually be capable of filling senior management positions within its Sales Organisation. It is essential that candidates should already have had considerable experience of selling, engineering materials in the field and have progressed into a junior or middle managerial position. This opportunity offers very good prospects and an attractive commencing salary. Age range 30/35.—Write, stating full details of age, experience, together with an indication of present earnings to BOX J 832, Offices of ENGINEERING.

DEVELOPMENT ENGINEERS, ELECTRICAL AND MECHANICAL, aged 28-35, required by THE MORGAN CRUCIBLE CO., LTD. Applicants who should be graduates must have had either experience of electronic circuitry or several years' practical experience of test-bed and laboratory test procedures. Work would be mainly on the design and application of new test methods and equipment relating to the testing of small carbon and sintered metal components.—Write, giving particulars of experience and qualifications to the STAFF MANAGER, BATTERSEA CHURCH ROAD, S.W.11. J 837

Engineering Design Office working on Development of Excavators and other Civil Contractors' plant offers interesting opportunity for

DESIGNER/DRAUGHTSMAN with Mechanical and Constructional experience. Write or 'phone PERSONNEL MANAGER, BLAW-KNOX LIMITED, WATFORD. (Telephone: Watford 9291.) J 622

BRITISH PETROLEUM COMPANY LIMITED, has immediate vacancies for

CHEMISTS, CHEMICAL ENGINEERS AND MECHANICAL ENGINEERS for work in their United Kingdom Refineries and at their Research Station at Sunbury-on-Thames. Applications are invited from men with first or second class honours degrees or equivalent qualifications and who have fulfilled National Service obligations. Previous industrial experience desirable, but not essential. Age, preferably not above 33. Salaries within the range £650 to £1300, according to qualifications and experience. Excellent working conditions. Non-contributory Pension Scheme.—Write, giving full details QUOTING H.3297 to BOX 7913, c/o, 191, GRESHAM HOUSE, E.C.2. G 565

CHIEF VALVE DESIGNER with design and production experience of valves up to 36in. diameter bore. Excellent prospects for engineer with originality and initiative. Salary £1200 upwards. House available.—ROBERT CORT & SON, LTD., READING BRIDGE, READING. J 643

JOHNSON, MATTHEY & CO., LIMITED

have vacancies for

DRAUGHTSMAN, ARCHITECTURAL.
DRAUGHTSMAN, MECHANICAL ENGINEERING.

Starting salary from £650 according to age and qualifications. Conditions of service also include free lunches, annual bonus, superannuation scheme, five-day week. Applicants who should be between 25 and 30, and have had technical education up to Ordinary National Certificate, are requested to apply, stating age, experience, etc., to the SECRETARY, 73/83, HATTON GARDEN, LONDON, E.C.1. J 826

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(a) Mechanical and By-Product Plant.
(b) Pipework.
(c) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week ; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3. G 550

Seventy-five pounds per month and upwards according to experience offered for

EXPERIENCED DESIGNER in R.C. as applied to commercial buildings. Pension scheme and a permanent position with an old-established company in their London Head Office. Five-day week. A vacancy also exists for Designer/Draughtsman working under Senior Designer with salary from £50 p.m.—Reply BOX G 587, Offices of ENGINEERING

DRAUGHTSMEN required, preferably with some experience in design of any of the following: Machine Tools, Jigs and Fixtures, Press Tools or Dies and Moulds. Good conditions of employment. Starting salary according to qualifications, advancement on merit. Firm has good Superannuation Scheme.—Write stating full technical and practical training and experience, etc., to CHIEF PLANT ENGINEER, THE SINGER MANUFACTURING CO., LTD., CLYDEBANK. J 700

PHYSICIST-GRADUATE in pure or applied science required for laboratory engaged in a wide variety of research and development, some experience in industrial research desirable but not essential. —Applicants should state age and give details of education and experience and should be addressed to the SECRETARY, BARR & STROUD, LTD., ANNIESLAND, GLASGOW, W.3, under reference 927/T-15. J 716

ELECTRICAL ENGINEER.

COURTAULDS LIMITED require an additional Electrical Engineer for their Electrical Engineering Headquarters in Coventry.

The work will be with a section covering a wide range of activities from telecommunications to power consumption and commissioning tests on all types of industrial machinery and switchgear.

Applicants should have a University degree or H.N.C. in Electrical Engineering. An apprenticeship or some previous works experience will be an advantage.

Candidates should write for a detailed form of application to the DIRECTOR OF PERSONNEL, COURTAULDS LIMITED, 16, ST. MARTINS-LE-GRAND, LONDON, E.C.1, quoting reference number B.32. J 598

An interesting and progressive appointment is about to be filled by a well-known Industrial Company concerned with the introduction of modern management methods. There will be a preliminary period of training during which the successful applicant will be paid up to £1000 per annum. The essential qualifications are a University Degree in Engineering, Works training or apprenticeship, and some experience of executive responsibility in a production department. The prospects are outstanding for a man of personality and drive. Applications are invited from **ENGINEERS** of 28-32 years of age who should send full details of their qualifications and experience in confidence to BOX J 819, Offices of ENGINEERING.

MECHANICAL DRAUGHTSMAN required in London Office of Consulting Engineers for layout of generating plant in hydro-electric power stations. Previous experience in this class of work not essential but starting salary according to qualifications with good prospects for advancement. Apply KENNEDY & DONKIN, 12, CAXTON STREET, S.W.1, quoting reference HH. J 617

CHEMICAL PLANT DESIGNER/DRAUGHTSMEN AND COMPETENT DETAILERS required by ASHMORE, BENSON, PEASE & CO., STOCKTON-ON-TEES. Must be experienced in the layout and detailing of Chemical Plants, pipe flow diagrams, pressure vessel design, etc.

Maximum assistance given in obtaining accommodation. Pension scheme, Technical Library and sports facilities available.

Apply stating age, experience, etc., quoting Ref. C. to STAFF PERSONNEL OFFICER. G 568

BRITISH PETROLEUM COMPANY LIMITED has a vacancy for a

STATISTICIAN in the Physics Section at its Research Station at Sunbury-on-Thames. Applications are invited from men who have completed a degree course in Statistics or who have had equivalent experience. Work will be on statistical problems in the oil industry including statistical design of experimental programmes. Applicants should be capable of co-operating fully with Research Staff and of ensuring that statistical techniques are used to the best advantage. Knowledge of the oil industry is not an essential. Excellent working conditions. Non-contributory Pension Scheme and Luncheon Club facilities. Write giving full details, quoting H.3308, to BOX 8207 c/o 191, GRESHAM HOUSE, E.C.2. G 597

PETER BROTHERHOOD, LTD., Peterborough, require

DRAUGHTSMEN (SENIOR AND JUNIOR) preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme.—Write, giving full details age, experience and salary required. Z 428

CHIEF PLANNING ENGINEER required to initiate and supervise the production methods of small internal combustion engines. He must have had considerable experience of methods used on large scale production in this or a similar field. Salary commensurate with qualifications. Pleasant working conditions. Attractive pension scheme.—Apply CHIEF PERSONNEL OFFICER, PETTERS, LTD., STAINES, MIDDLESEX. J 732

The following vacancies in the Staff of a large integrated Iron and Steel Works will shortly occur and applications are invited from suitably qualified metallurgist/chemists in the age range 28-35.

(1) **TWO SHIFT METALLURGISTS**—duties include quality control observations and liaison with Production Departments, mainly on the Steel Production side. These posts are suitable for younger men with a good theoretical background, who are keener on the production aspect than on laboratory work.

(2) **ONE FOUNDRY METALLURGIST/CHEMIST** for a Foundry manufacturing iron ingot moulds and general iron castings, including non-ferrous castings. A keen well-qualified person is required for this post, which may involve building up in the future a comprehensive technical control in a new Foundry, which may incorporate also the manufacture of steel castings.

All posts are pensionable and salaries will be adequate and commensurate with abilities.—BOX J 740, Offices of ENGINEERING.

PLANT INSPECTION ENGINEER required by International Group for an Oil Refinery in MIDDLE EAST. Age 24/35 years. Applicants should have had secondary education followed by technical training and five years' experience in inspection of refinery equipment. Alternatively, inspection experience with insurance company and M.O.T. certificate in Marine Engineering would be considered. Some refinery drawing office experience an advantage. Two year tour in first instance and substantial salary payable also while on leave. Married accommodation and free family passages available.—Write for application form to BOX E.G.484, c/o 191, GRESHAM HOUSE, E.C.2. J 750

THE GENERAL ELECTRIC COMPANY LTD. require for their Marine Organisation in London and the north of England,

ENGINEER REPRESENTATIVES with or without seagoing experience and willing to study and handle a wide range of Marine equipment including heavy and light engineering communications, cable, lighting, etc.

(1) **MECHANICAL AND ELECTRICAL ENGINEER,** Degree standard, age 30/40, with practical experience of steam turbines and/or turbo-electric machinery.

(2) **ELECTRICAL ENGINEER,** age 25/35, Degree or A.M.I.E.E. Standard; student or post-graduate works apprenticeship.

(3) **ELECTRICAL ENGINEER,** under 30, Higher National Certificate, student apprentice training.

Salary according to qualifications and experience.—Apply in writing to THE STAFF MANAGER, MAGNET HOUSE, KINGSWAY, LONDON, W.C.2, stating age and full personal record. J 741

WHESSOE LIMITED have a vacancy for an **ENGINEER** who is interested in the development of welding and metallurgy. Applicants should have a Higher National Certificate in Mechanical or Structural Engineering or equivalent qualifications. Welding experience whilst desirable is not essential. —Applications should be addressed to THE SECRETARY, WHESSOE LIMITED, DARLINGTON. J 742

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ASSISTANTS, Senior and Junior, for design work on major projects in Scotland.—BOX J 778, Offices of ENGINEERING.

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SENIOR AND JUNIOR DRAUGHTSMEN for project and contract work covering a wide field of mechanical, structural and hydraulic engineering. West End office, five-day week. Pension scheme, etc.—Applications please to BOX J 779, Offices of ENGINEERING.

THE BRITISH OXYGEN COMPANY LTD., require the services of a

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THE BRITISH PETROLEUM COMPANY, LIMITED, invites applications from

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Classified Advertisements continued on Page 86

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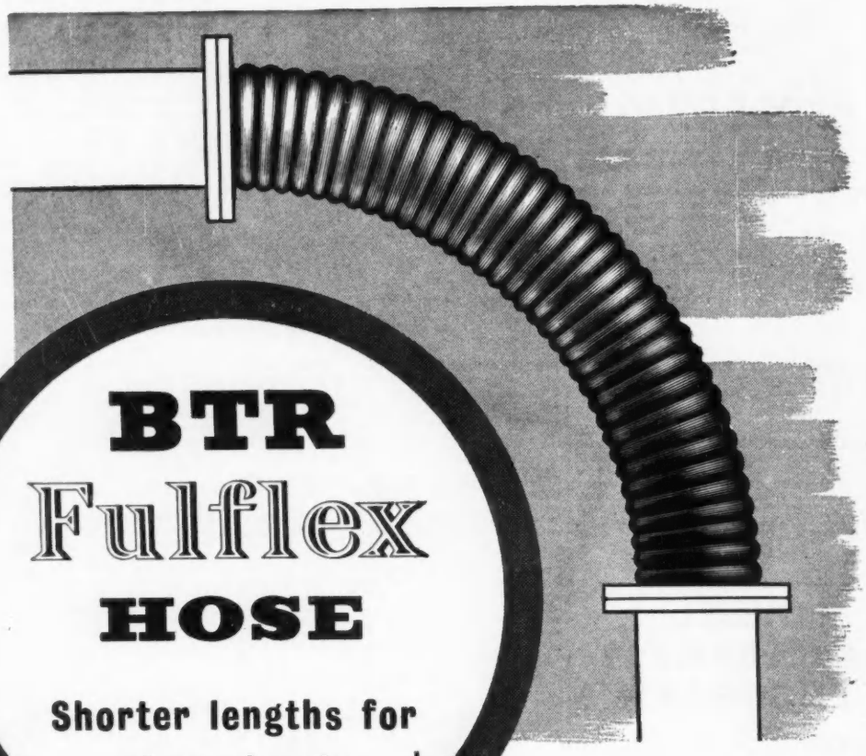

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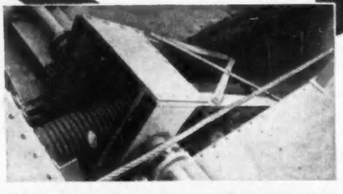

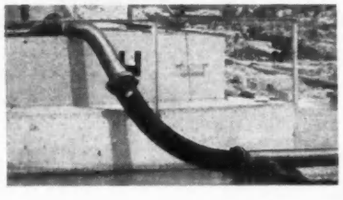

BTR Fulflex Hose can be used in shorter lengths than spigoted hose for carrying gravel and sand round sharp bends in pipe lines. Because connections are made without spigots, 6 ft. of BTR Fulflex will bend through the same angle as 8 ft of spigoted hose—6 ft of 8" bore, for example, bends through 90°.

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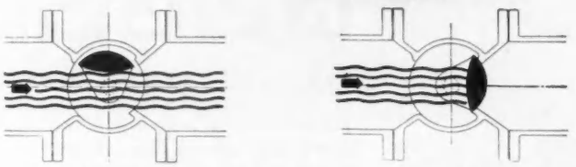

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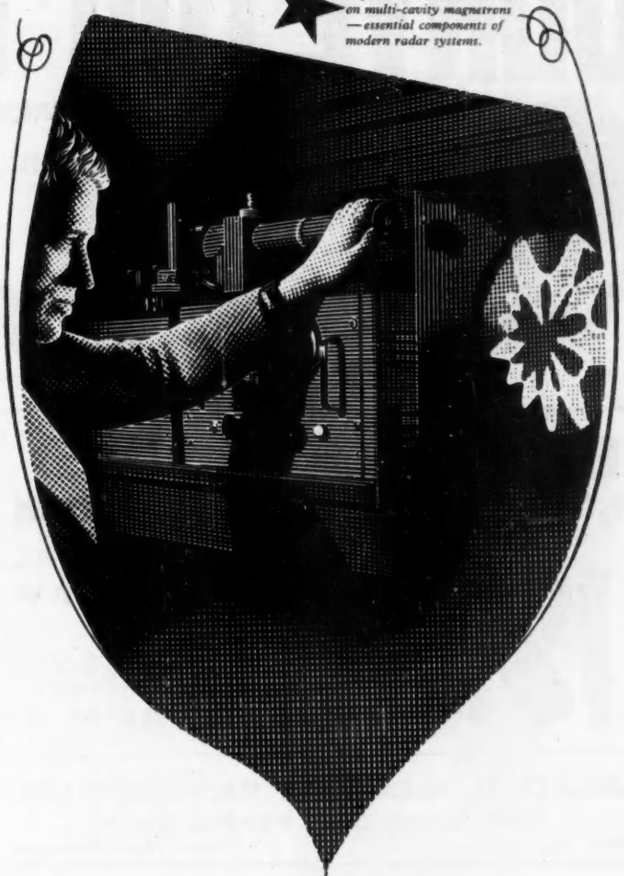

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This scientist is concerned with a specific problem in one particular field of electronics. But his work fits into the overall pattern of Mullard research—a pattern for progress. Working hand in hand with the designers of leading equipment manufacturers,

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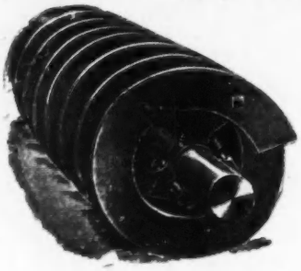

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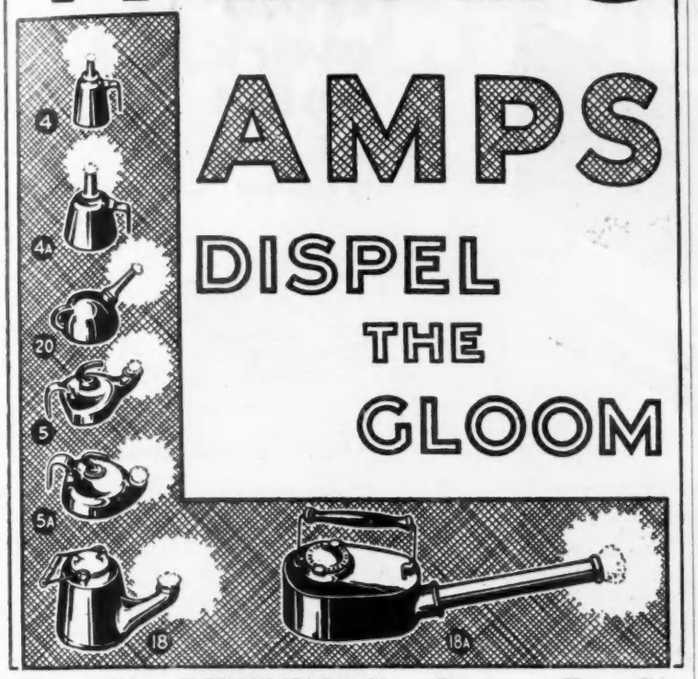

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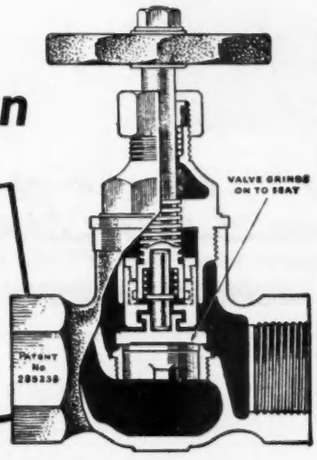

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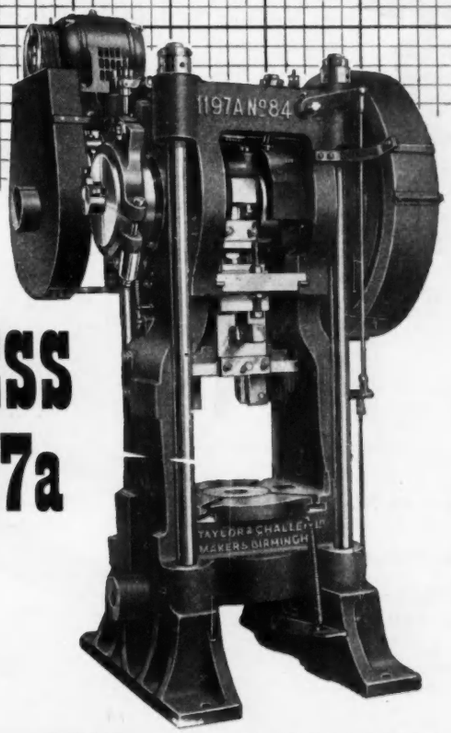

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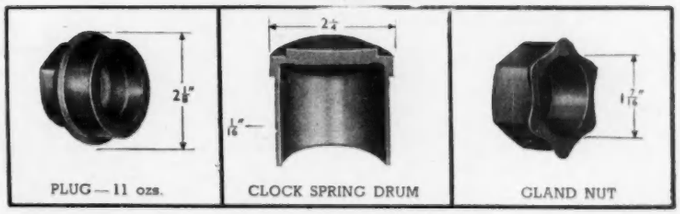

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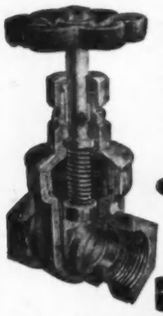

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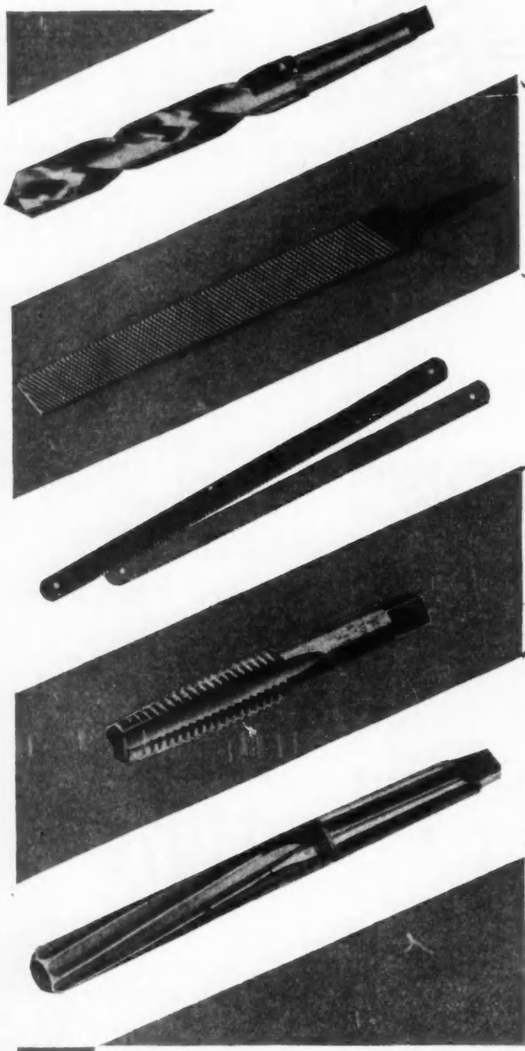

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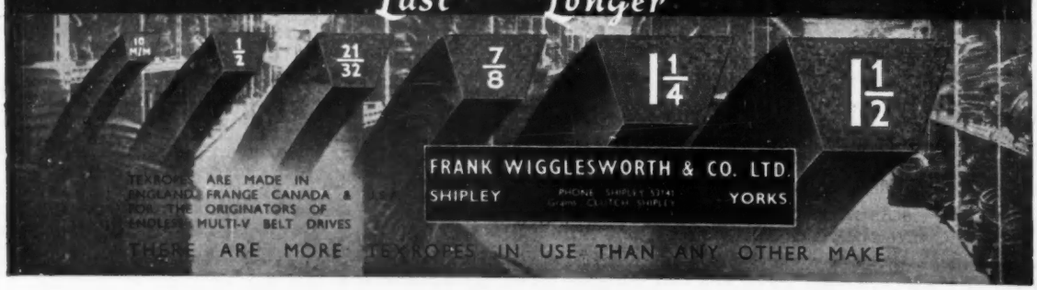

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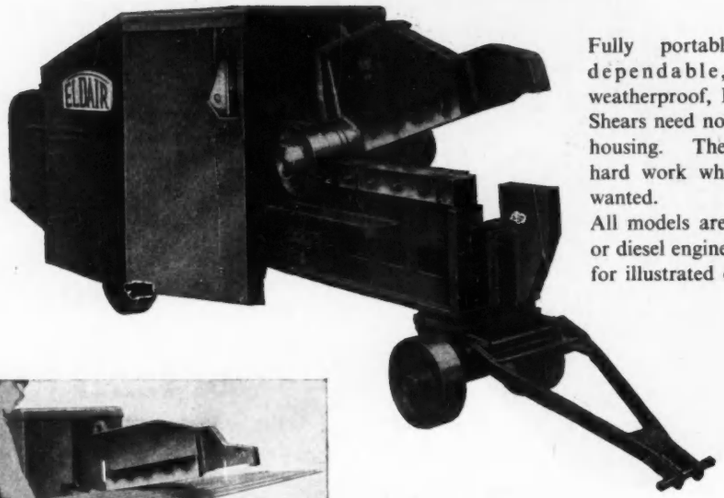

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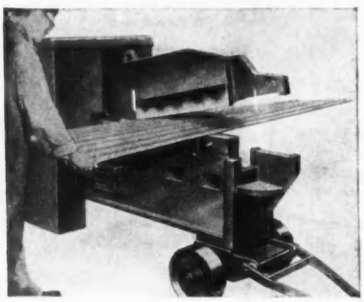

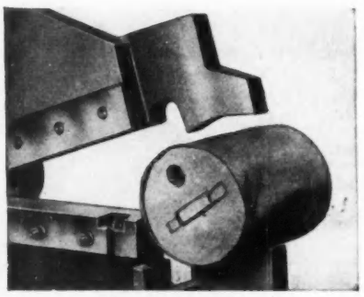

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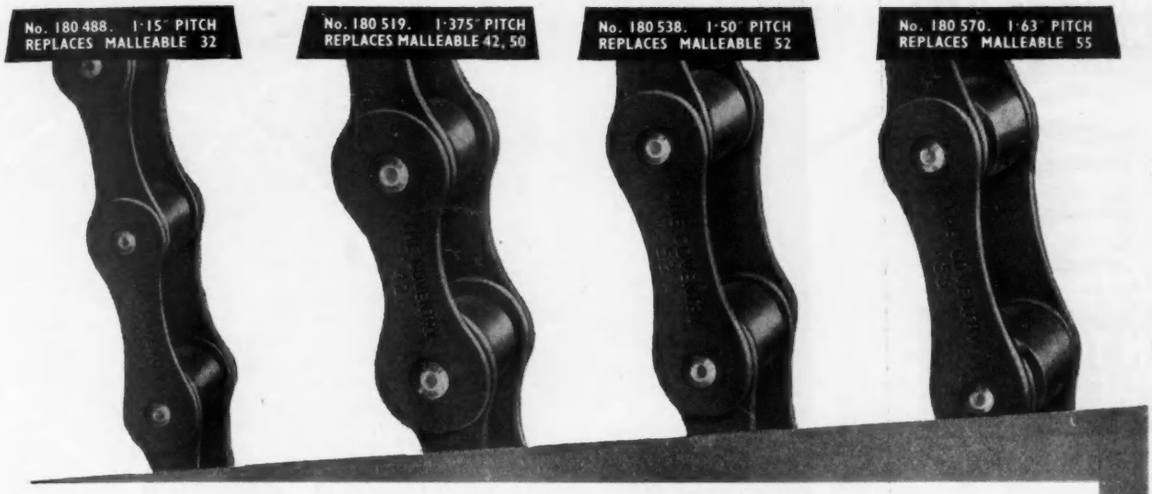
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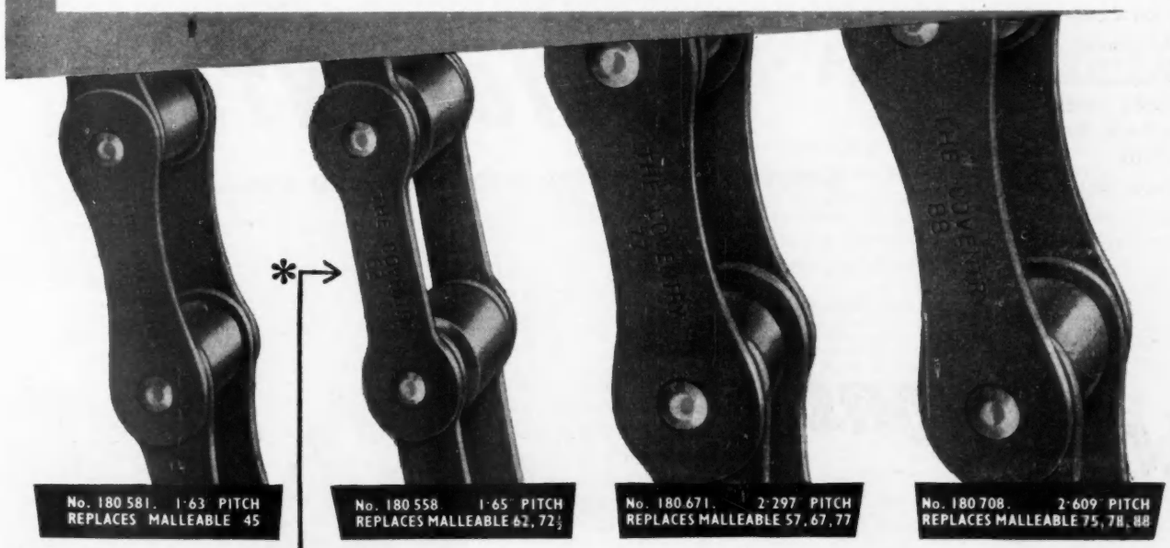
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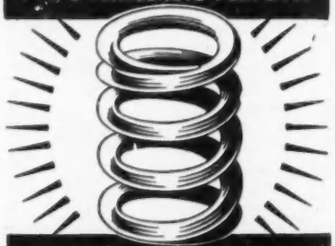

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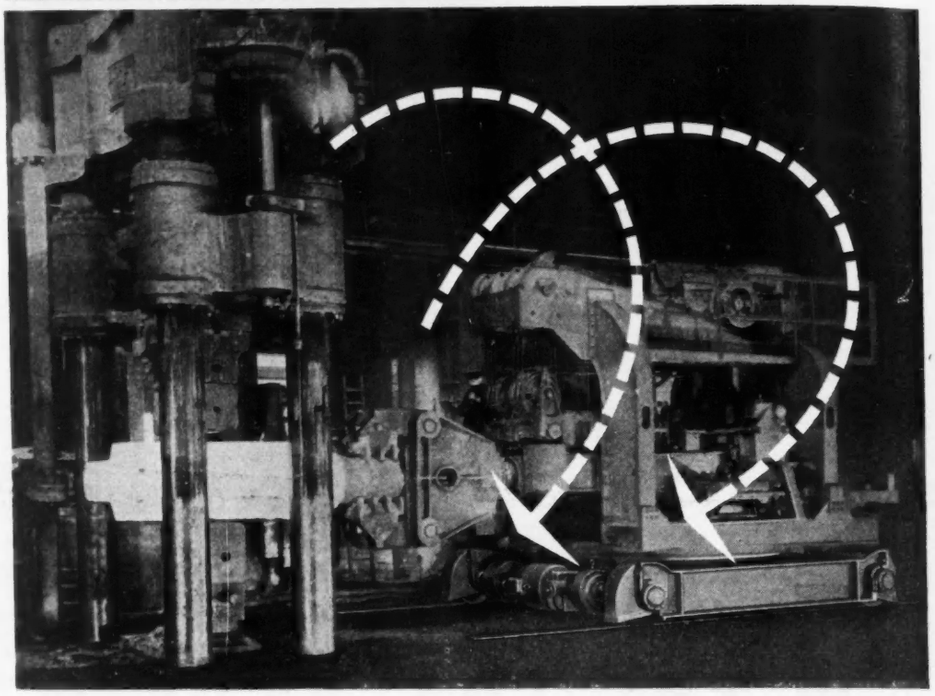

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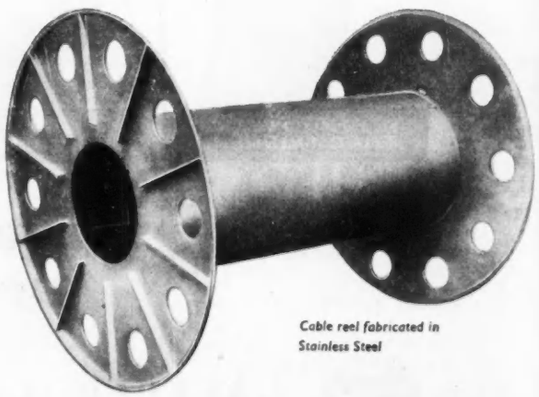

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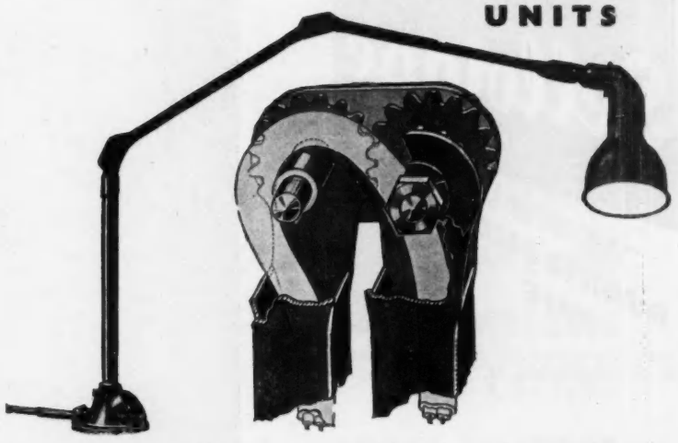

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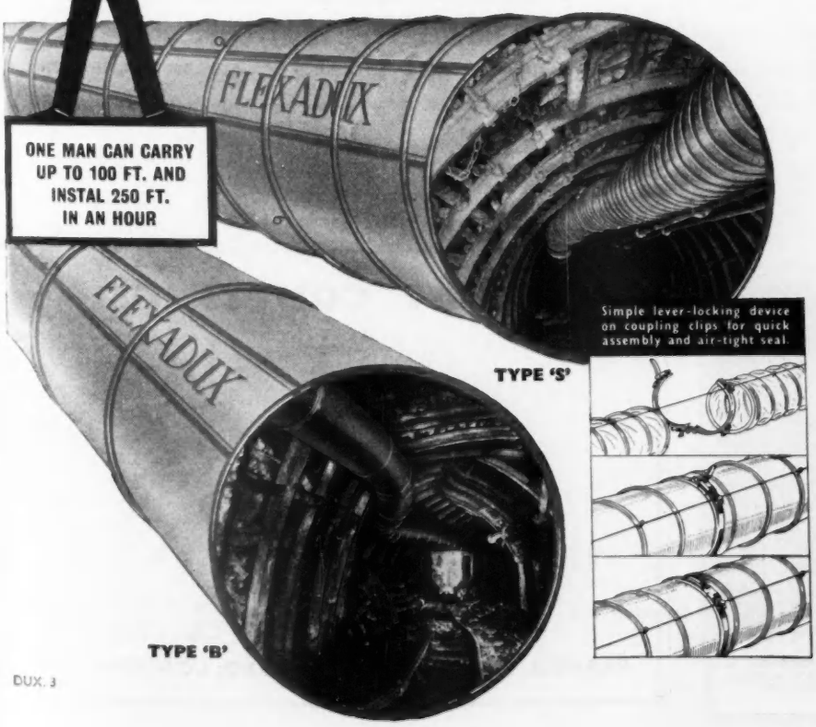

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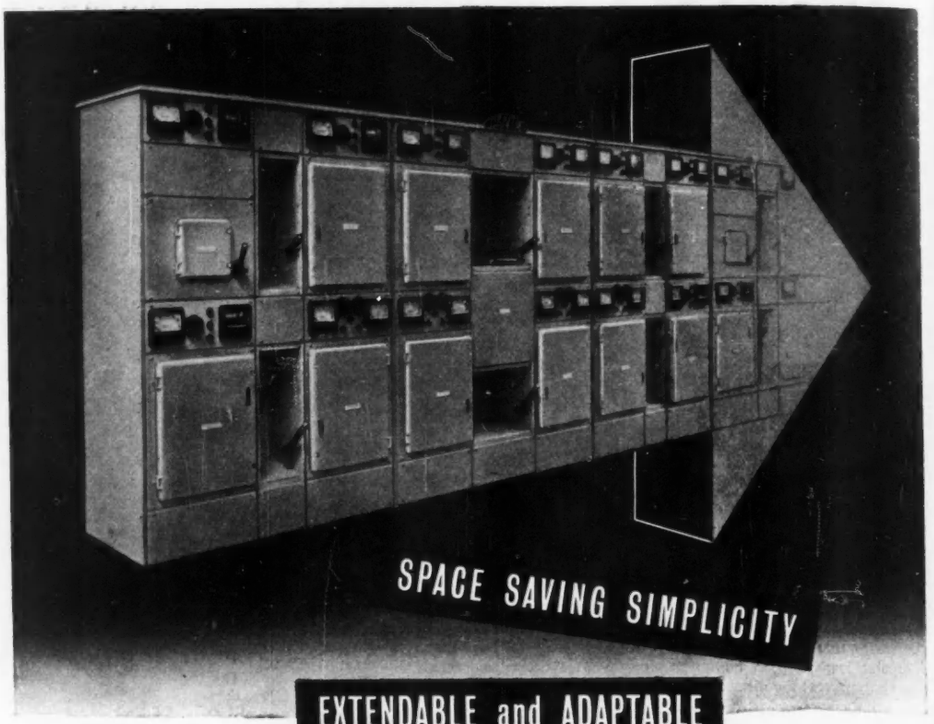

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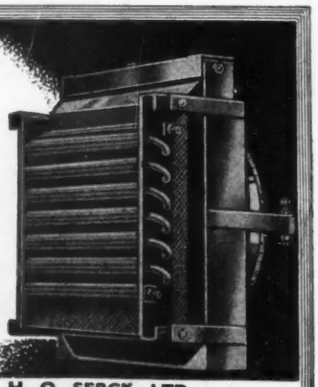

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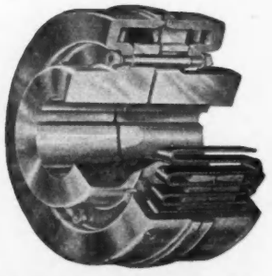

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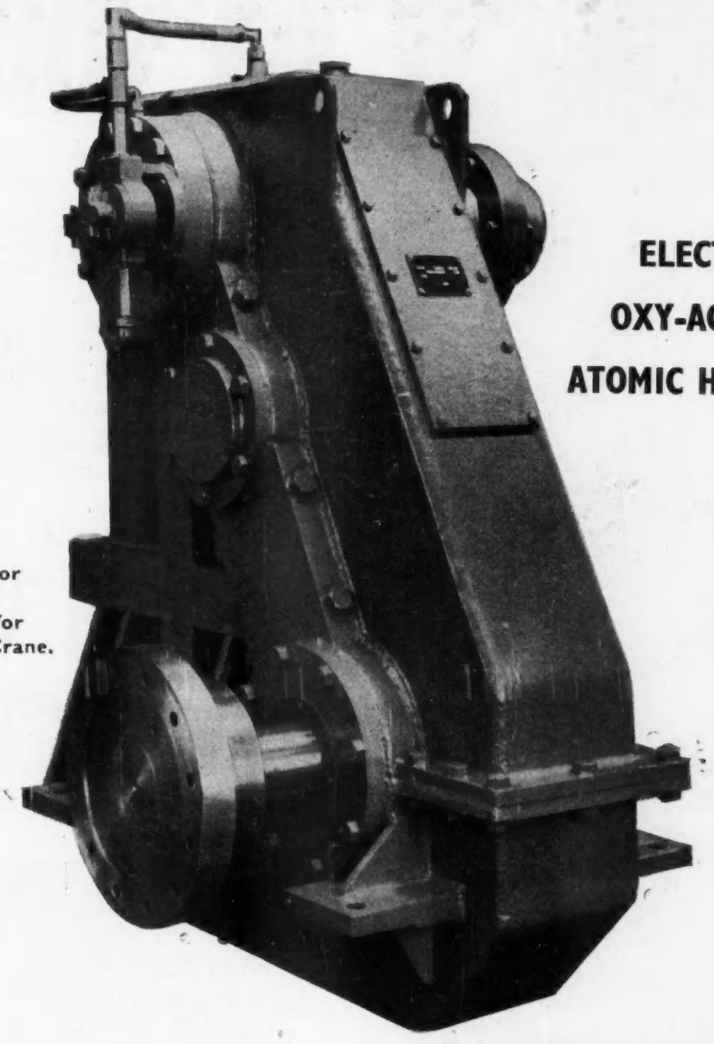

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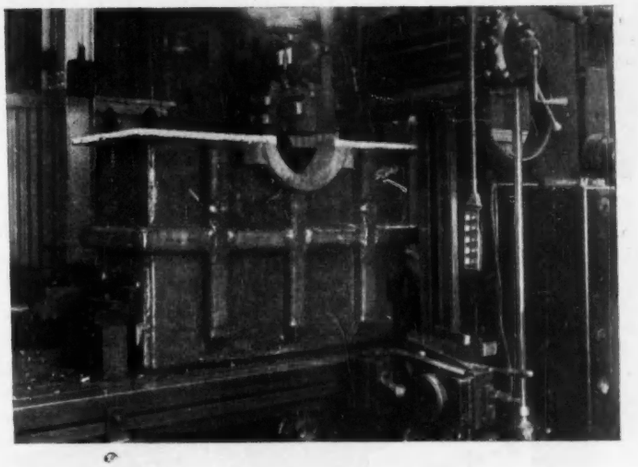

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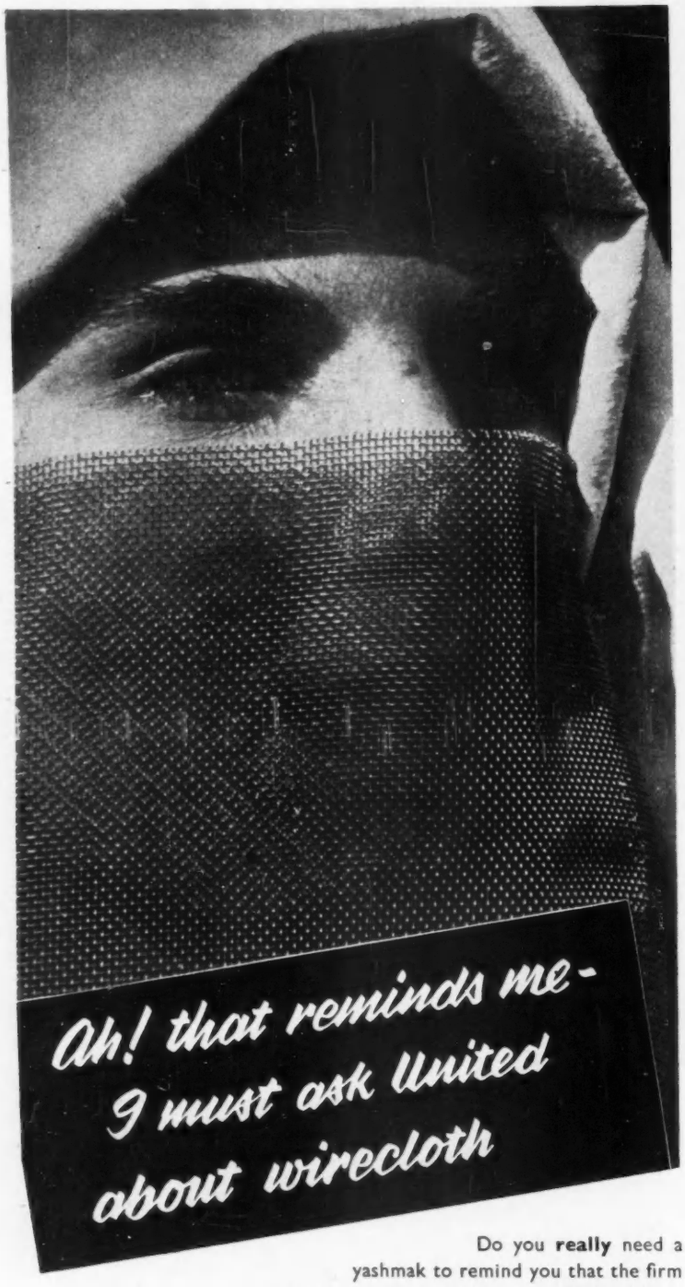

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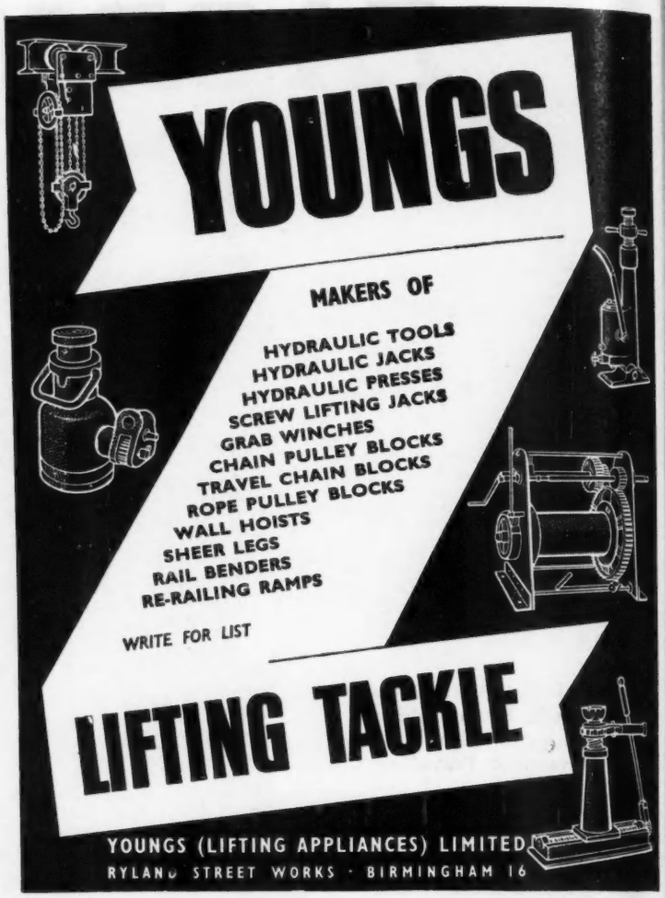

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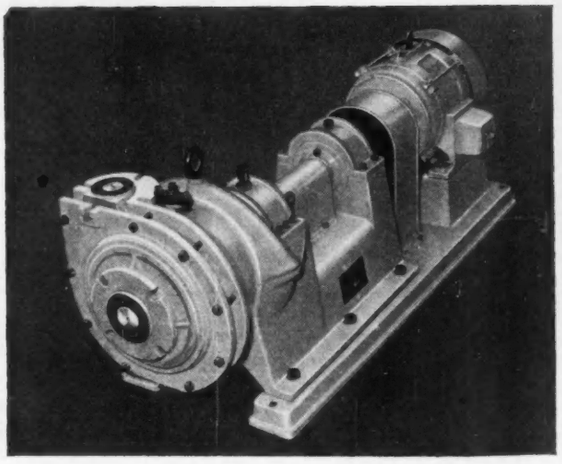

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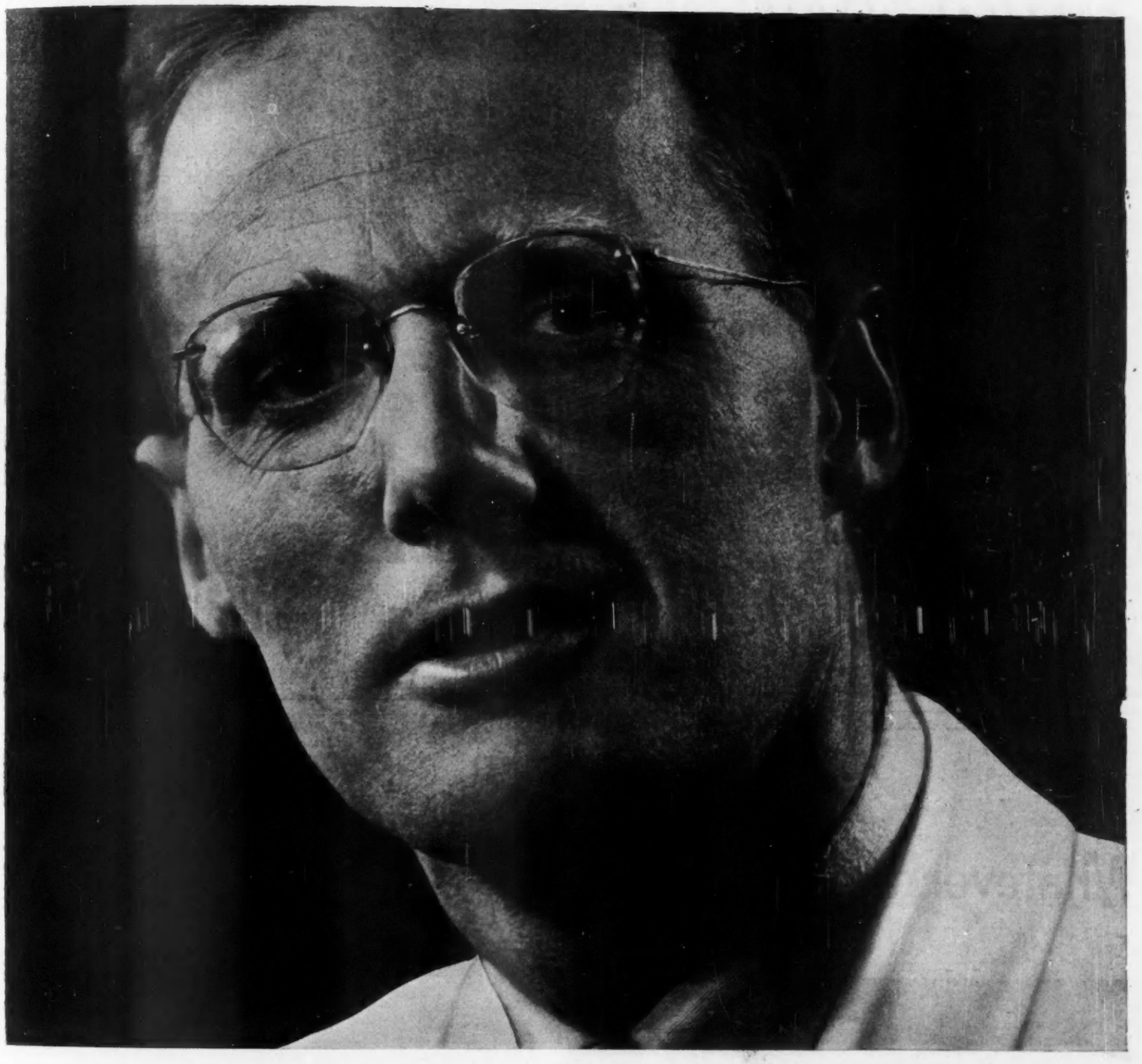

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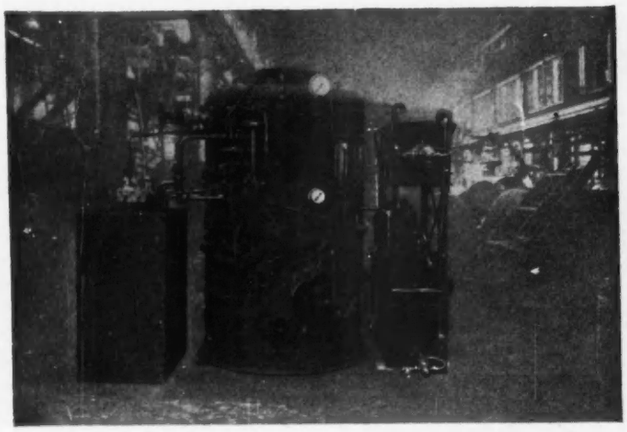

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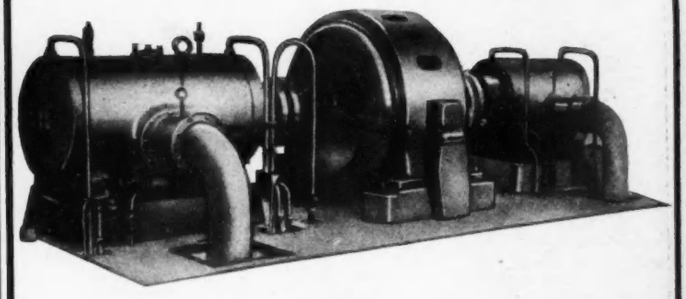

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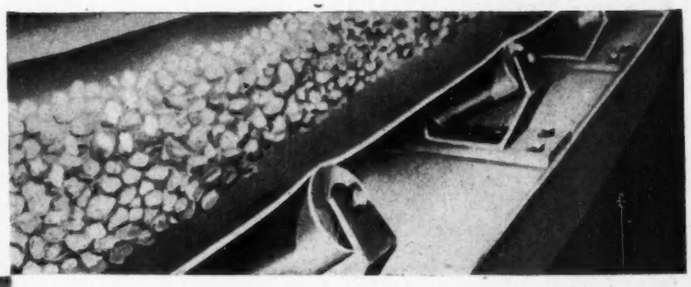
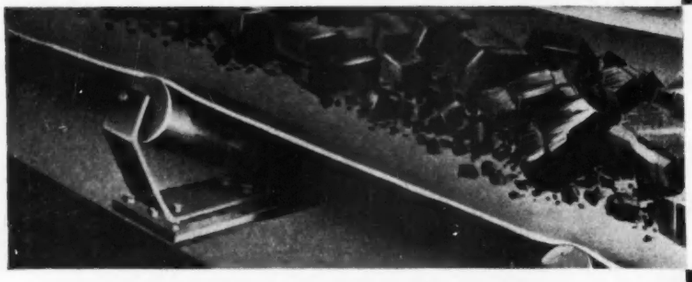


Coal



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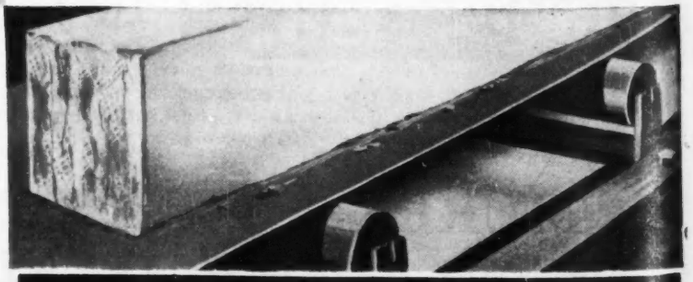

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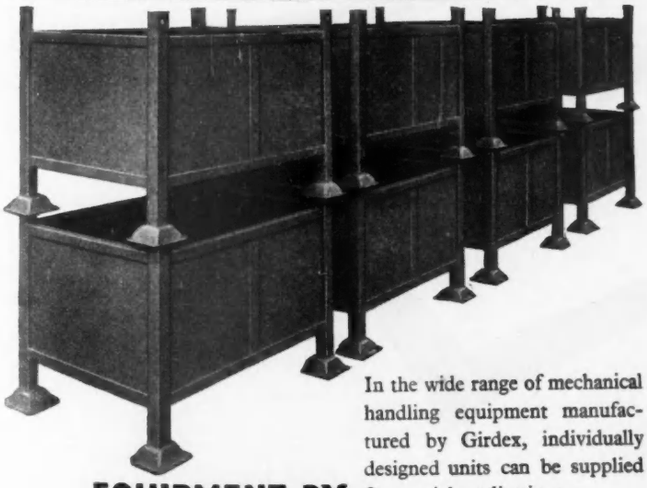

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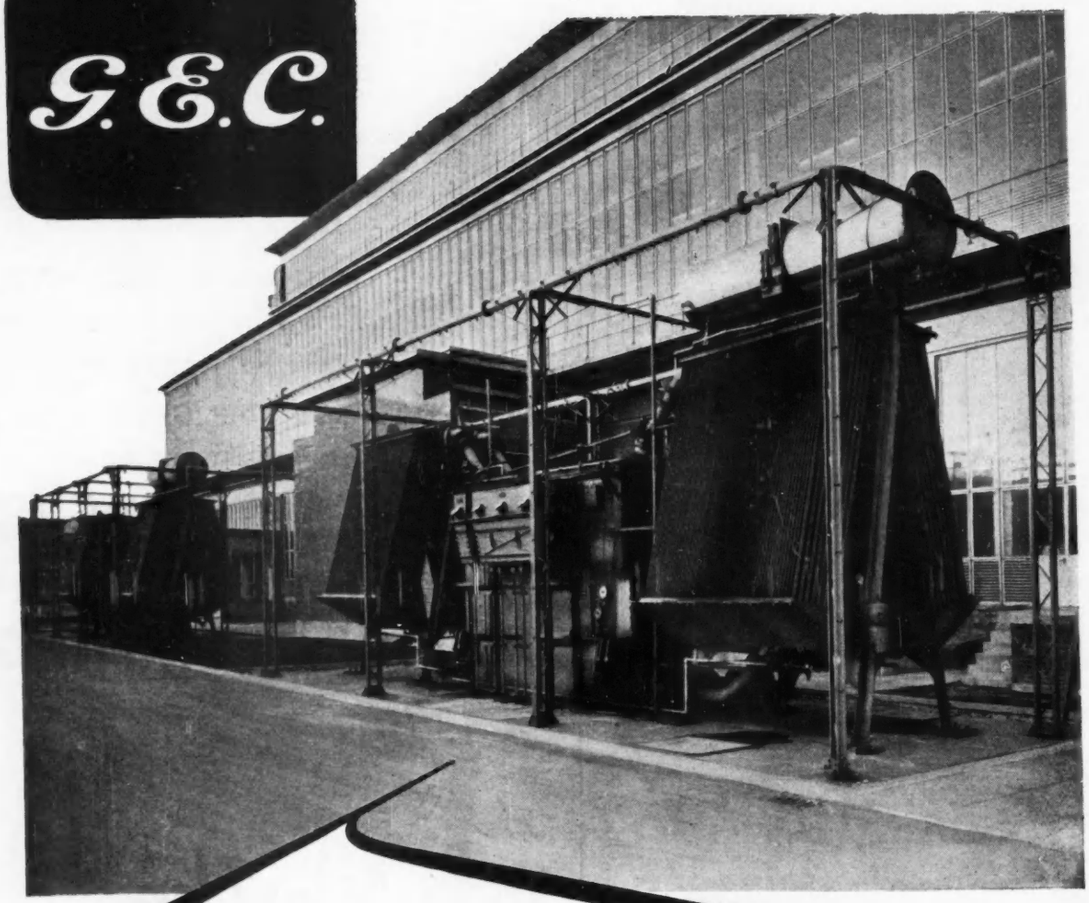

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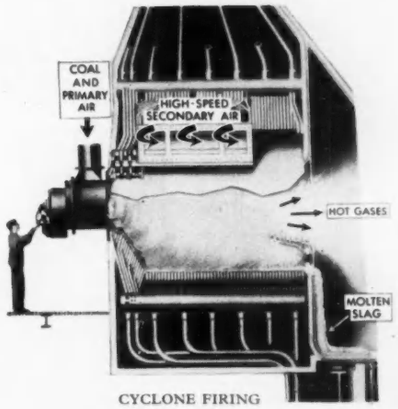
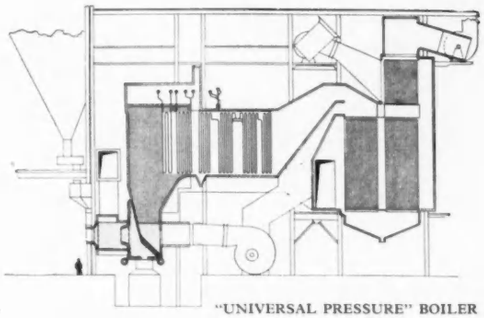


CYCLONE FIRING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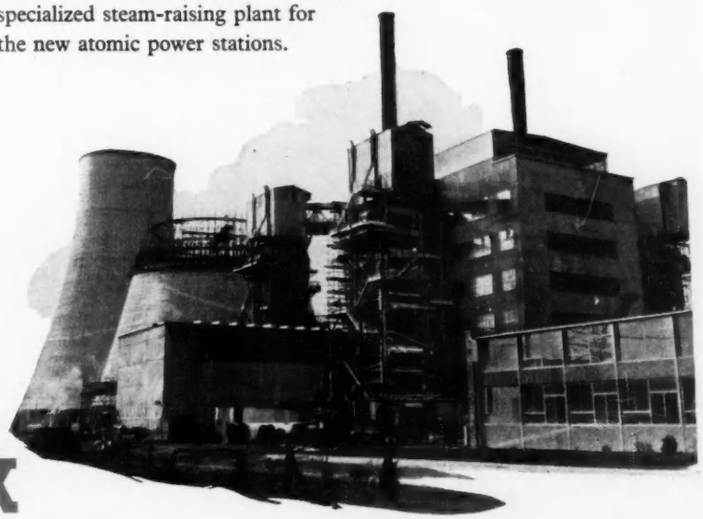
★ The Company has subsequently received orders approaching £6,000,000 in value for the manufacture of another 24 similar towers for the Calder Hall and Chapel Cross atomic power stations.

The history of electrical power generation is closely bound up with that of steam engineering and the major advances leading to more efficient, economical and reliable steam power generation, using increasingly low-grade, variable fuels, have been largely due to new developments in steam-raising plant and techniques, in which Babcock & Wilcox have continually led the way. Recent examples are the 'Cyclone' furnace and steam-generation at supercritical pressures, both of the highest importance in the more efficient use of 'conventional' fuels; and, as we move into the age of nuclear power generation, Babcock & Wilcox are again in the forefront with the design and manufacture of highly specialized steam-raising plant for the new atomic power stations.


Calder Hall atomic power station under construction, showing some of the Babcock steam-generating towers

all Babcock

BABCOCK & WILCOX LIMITED, BABCOCK HOUSE, FARRINGDON STREET, LONDON, E.C.4

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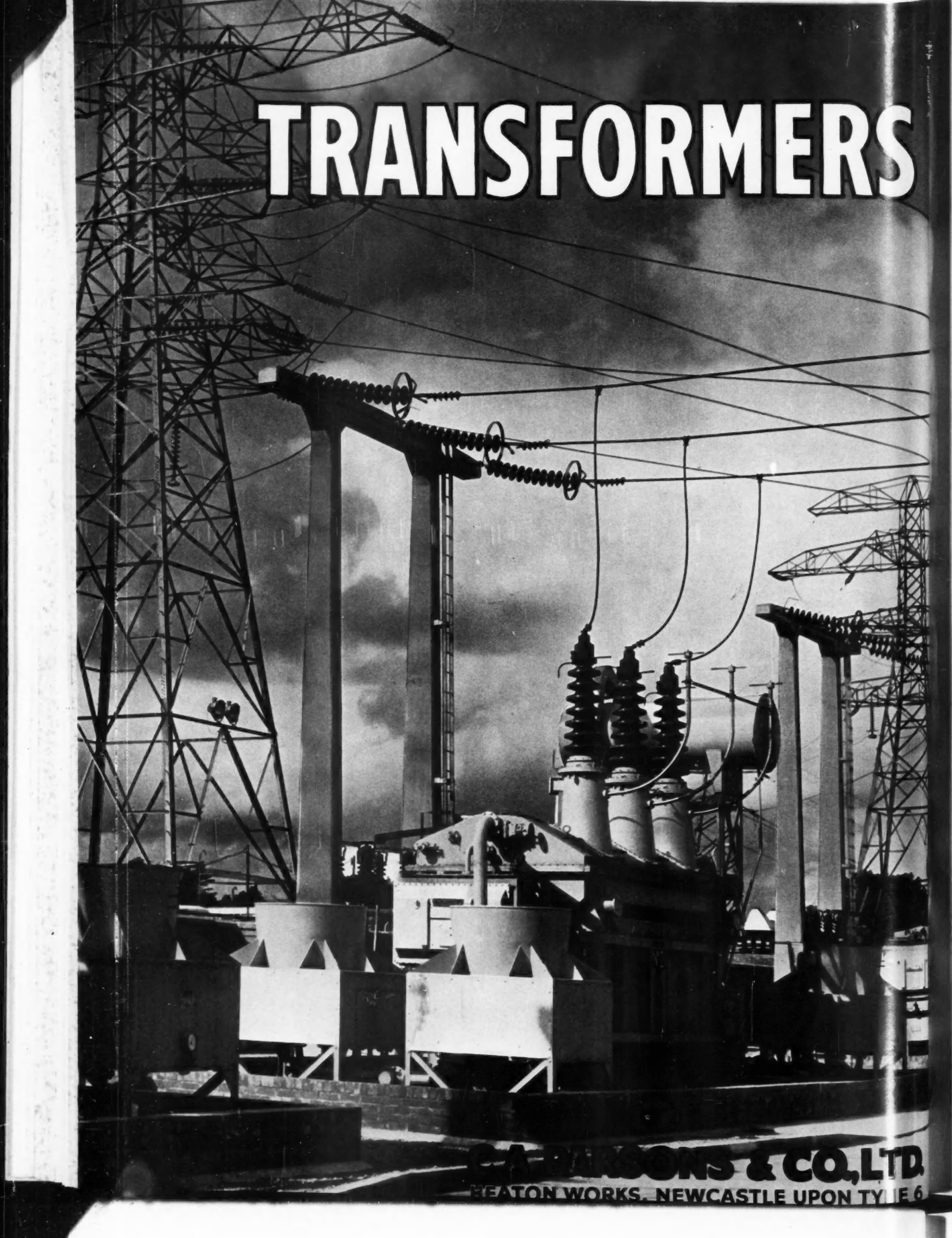
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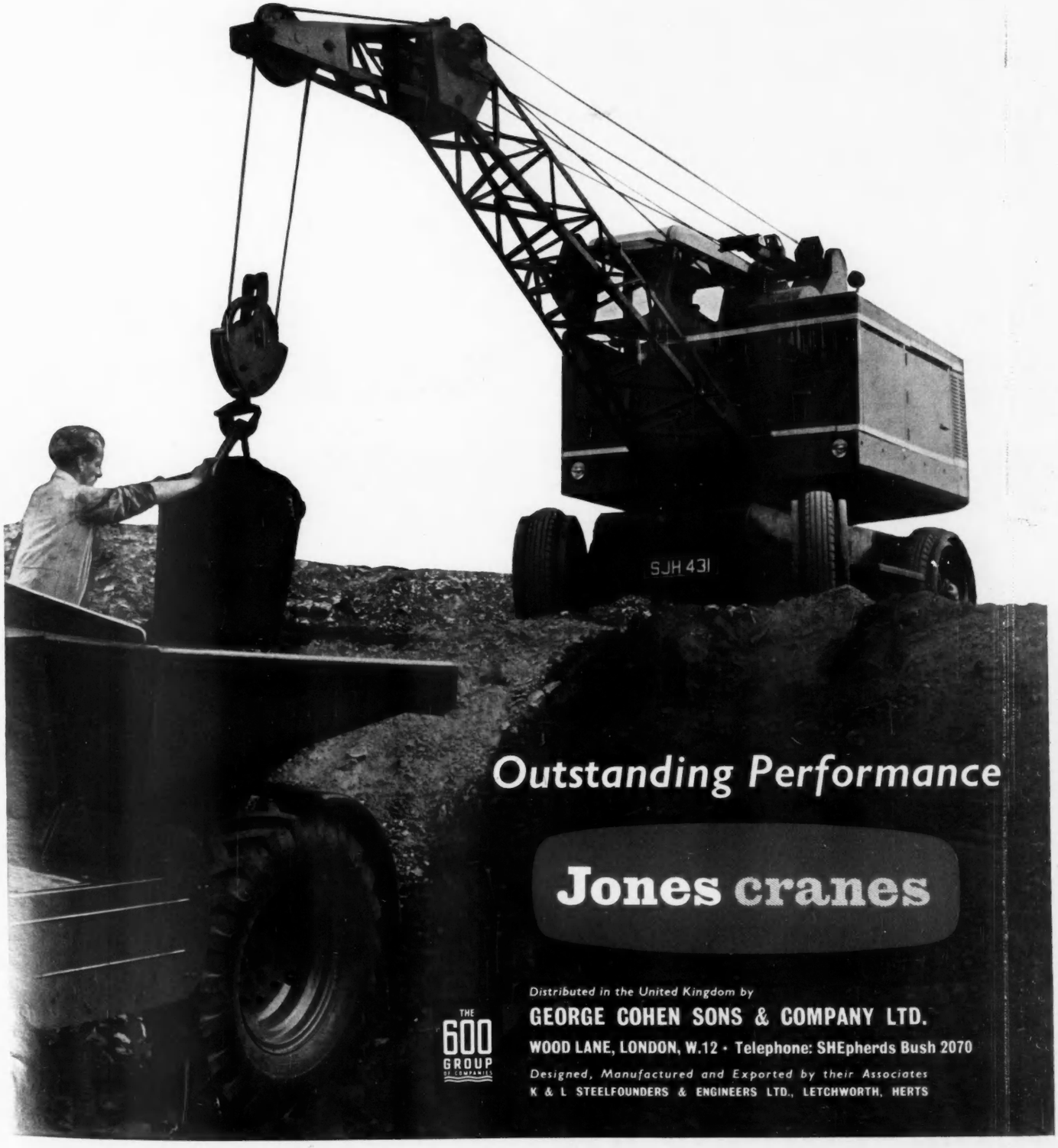

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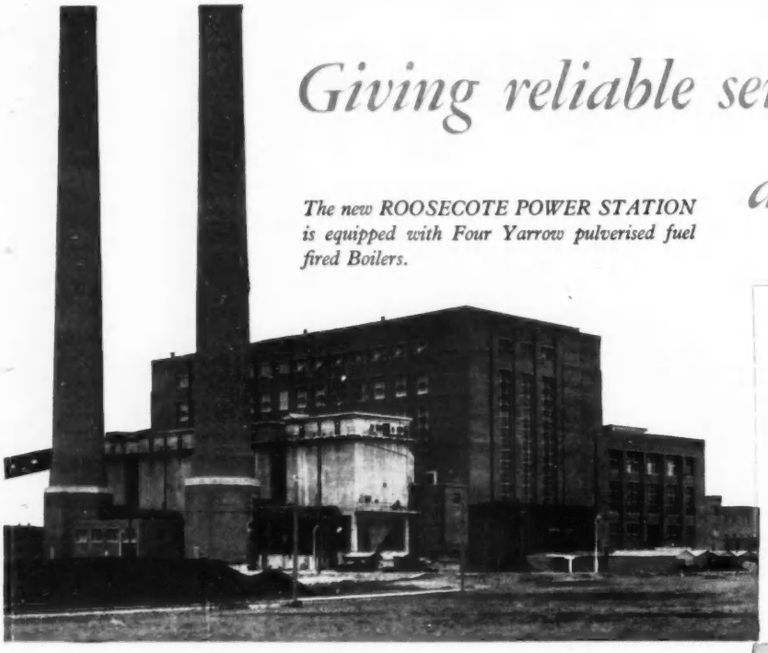

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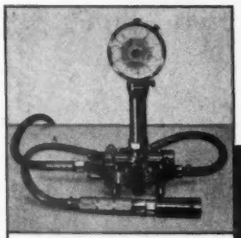
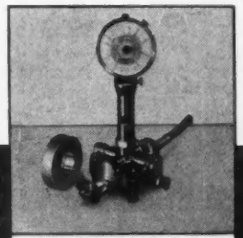
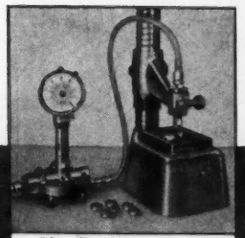
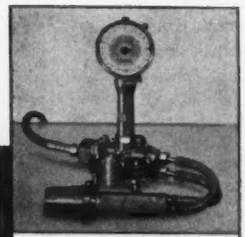

ETAMIC Air Comparator Unit with Plug.


Air Comparator in service with a ring.


Air Comparator in service with a feeler.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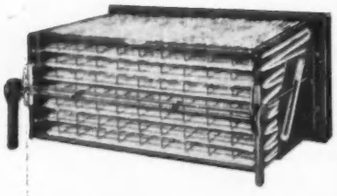

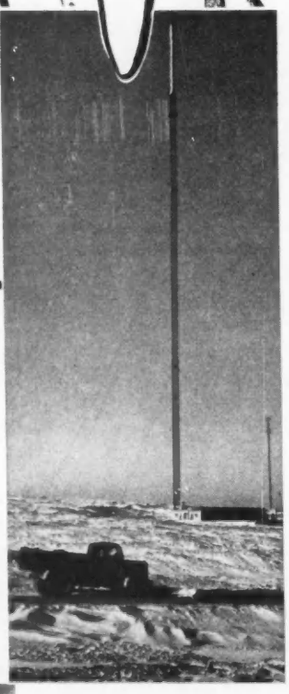

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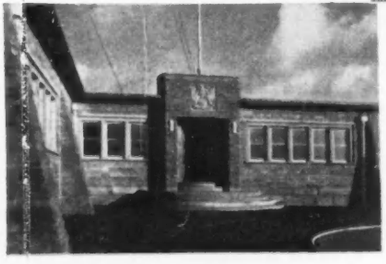

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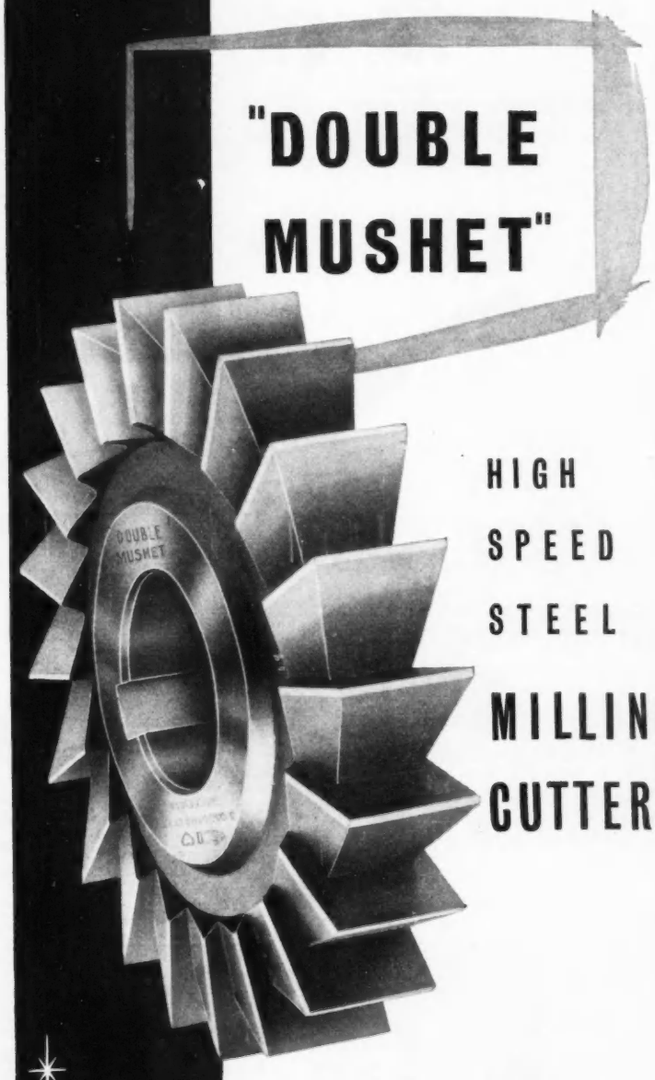

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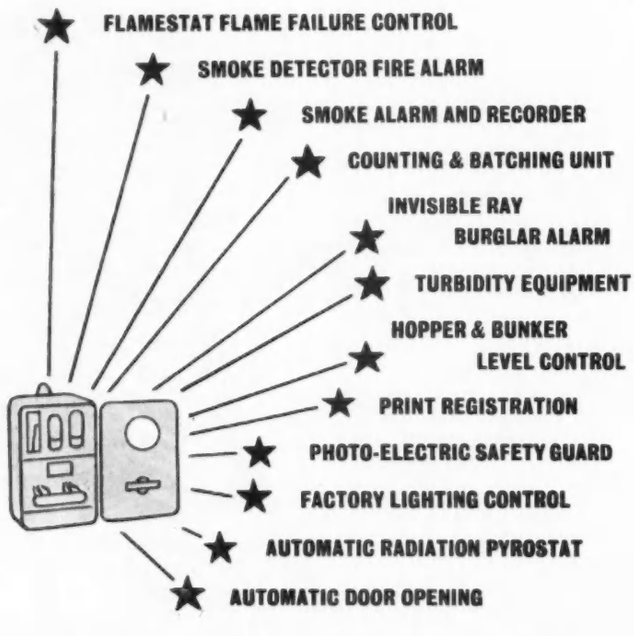

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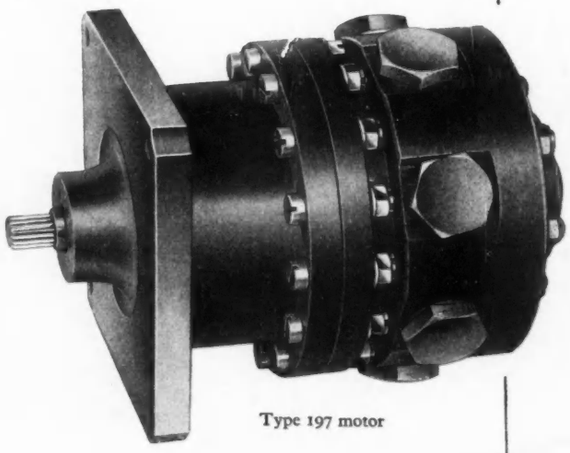

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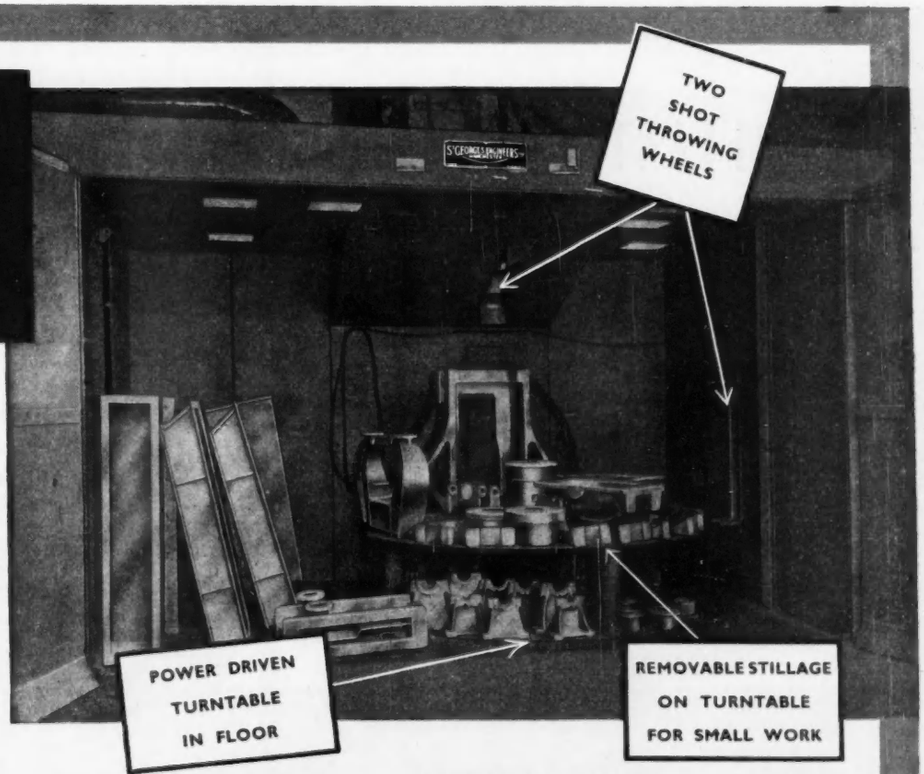

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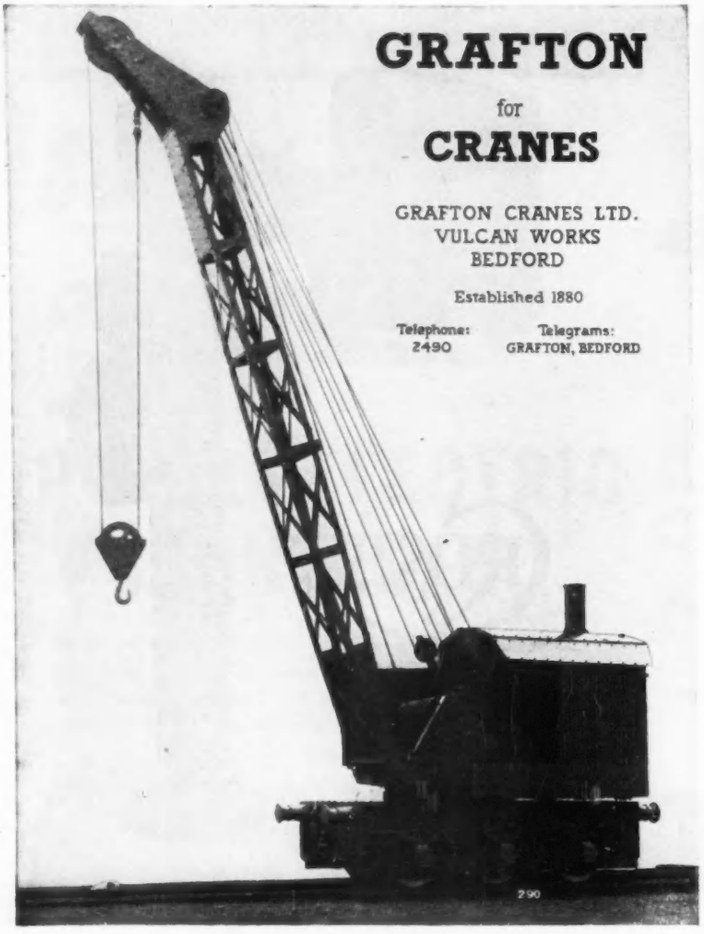

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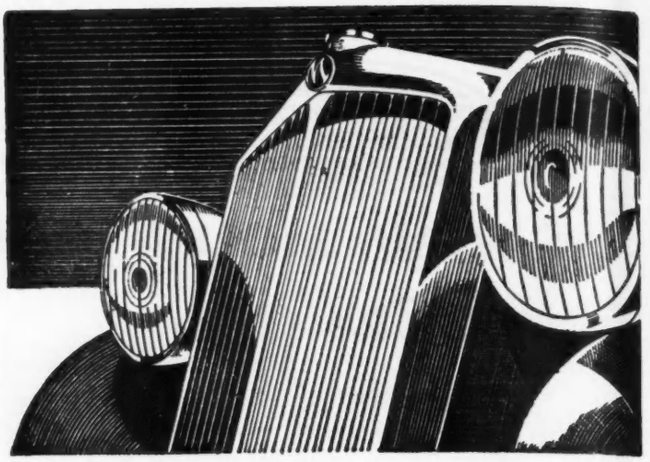

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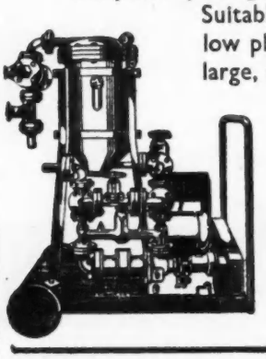

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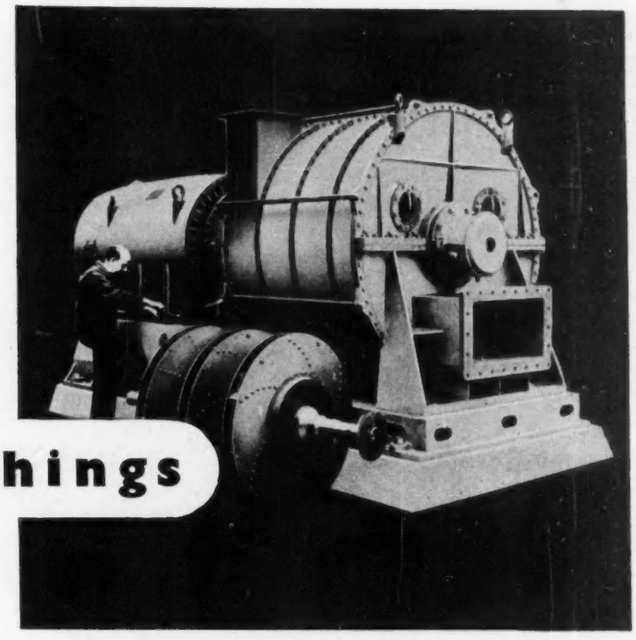

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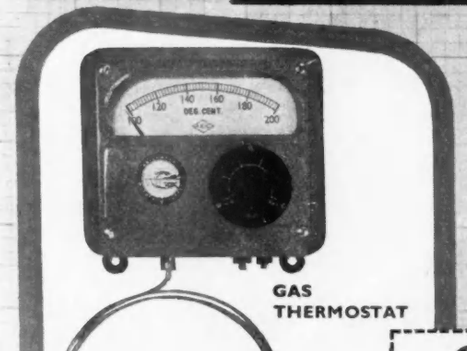

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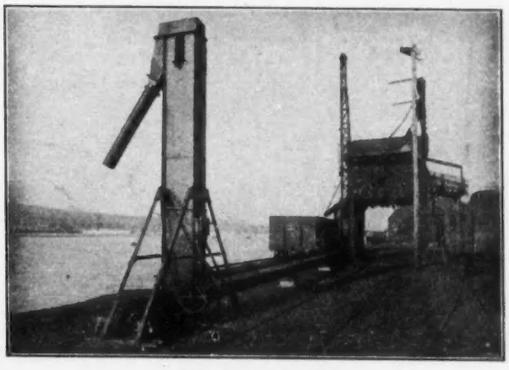

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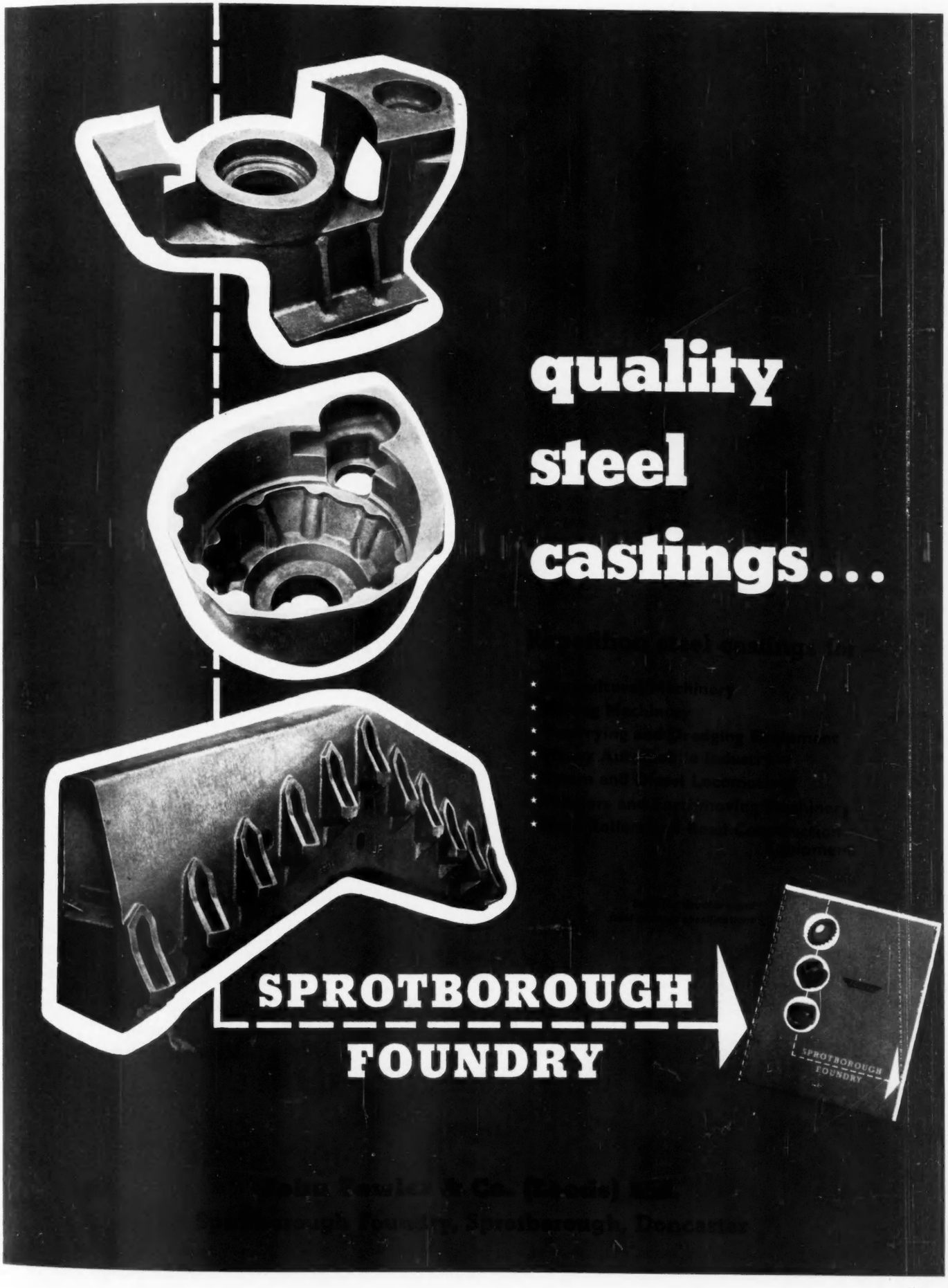
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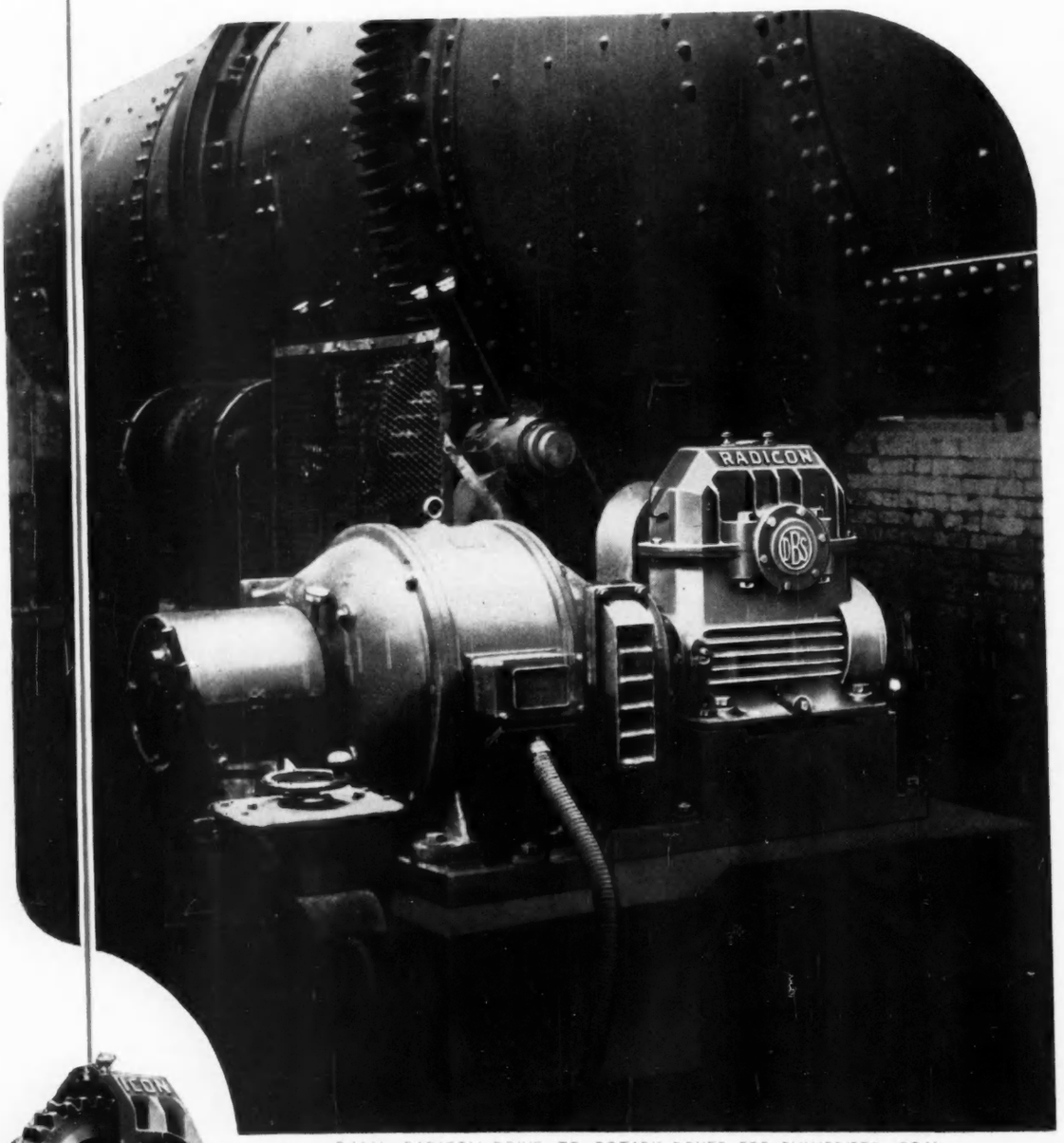

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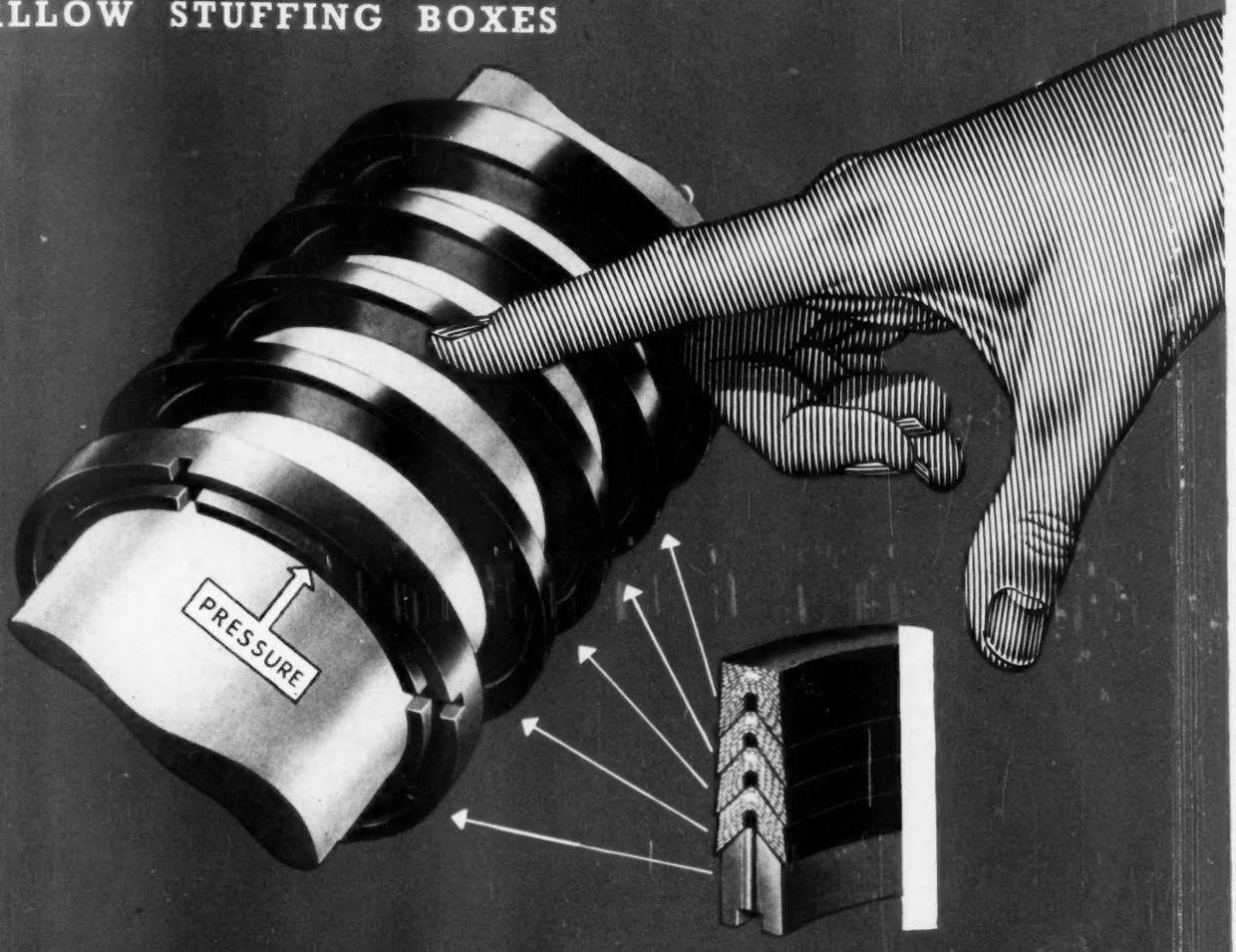
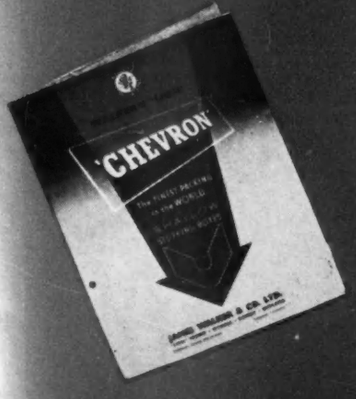


WALKER'S 'LION' CHEVRON



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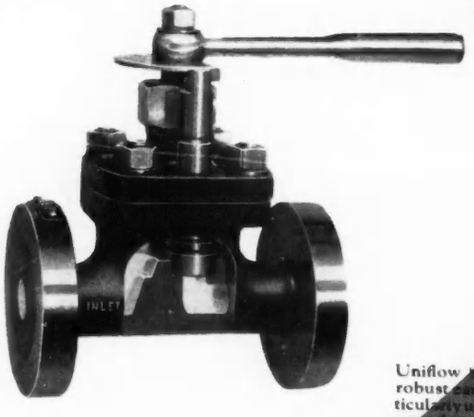

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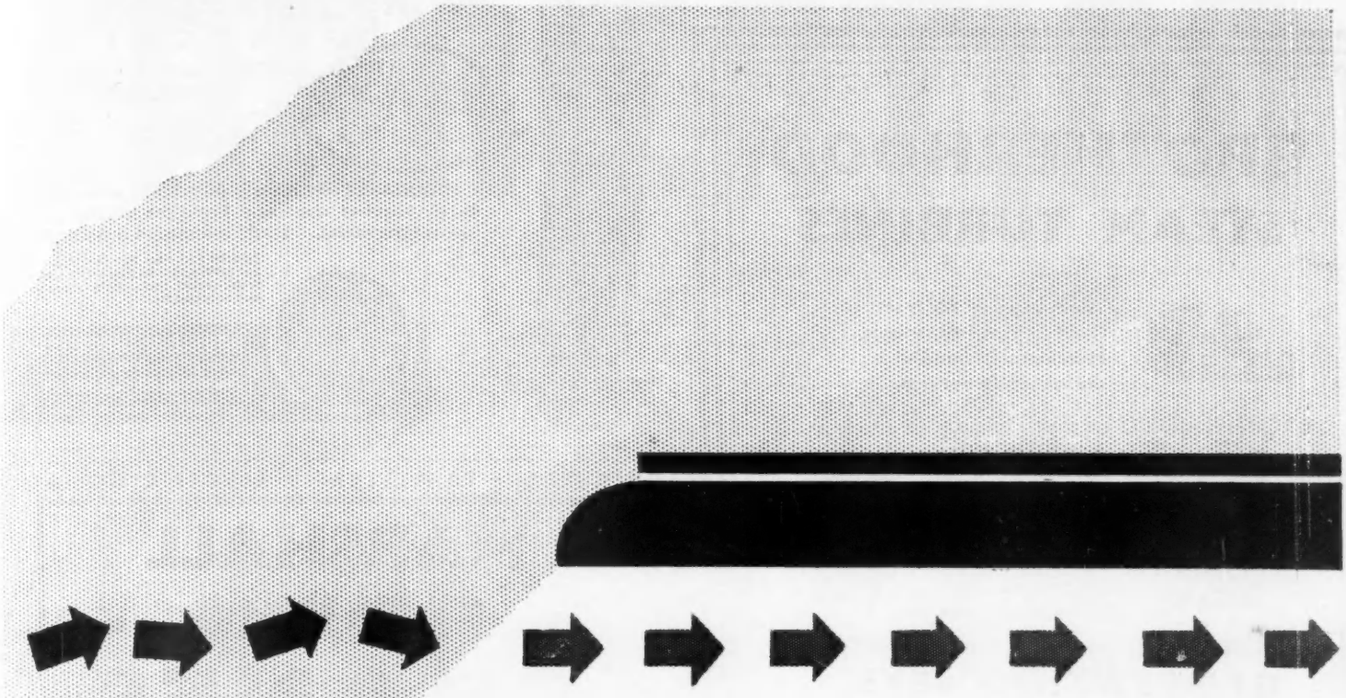

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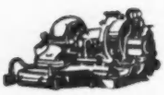

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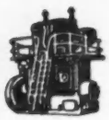

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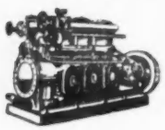

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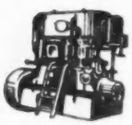

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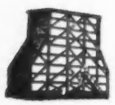

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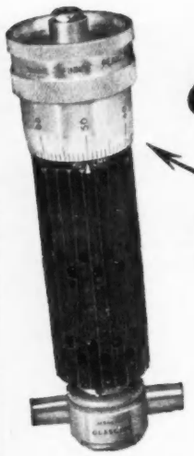

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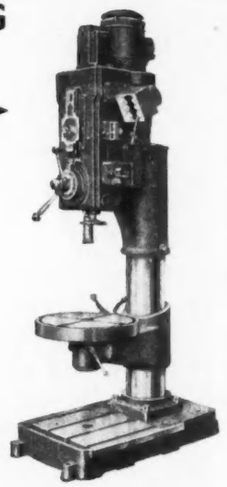

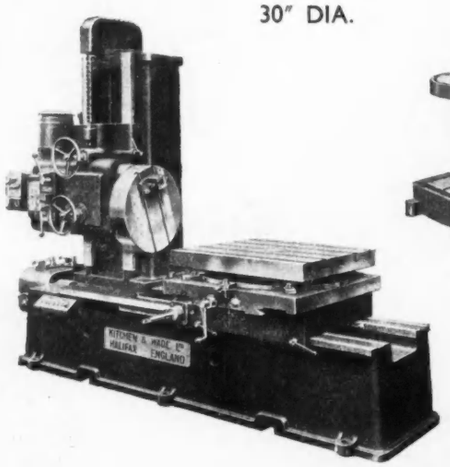

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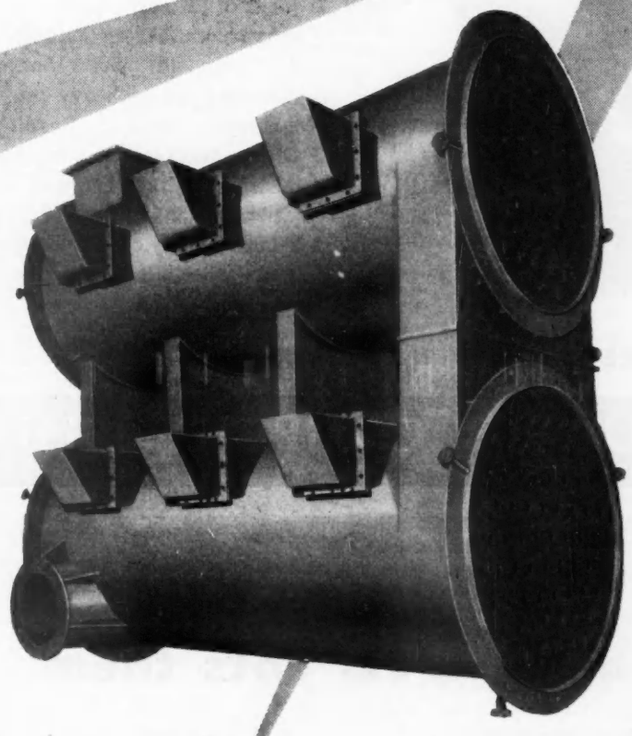

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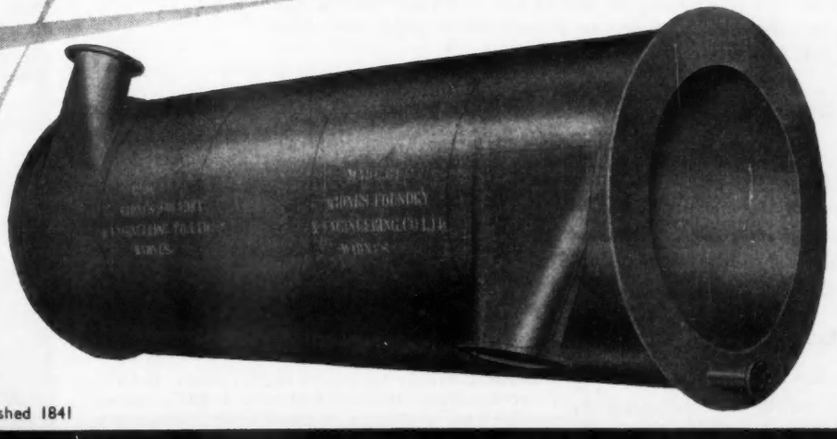

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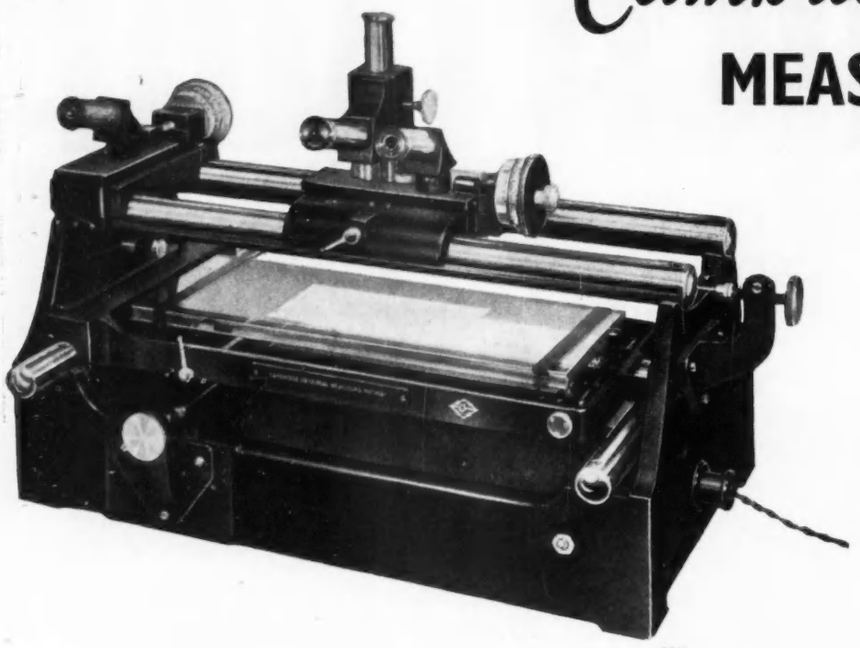

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(Photograph by courtesy of Keir & Cawder, Ltd.)

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ENGINEERING

An Illustrated Weekly Journal

Vol. 181 No. 4693 JANUARY 6, 1956

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RAILWAY ACCIDENTS

THE recent railway accidents, two attended by serious casualties, in one case aggravated by an outbreak of fire, have been the subject of considerable comment, most of it lacking in that sense of proportion essential to forming a reasoned opinion. Casualties, of course, create a deep and disagreeable impression, but they are largely fortuitous and do not by themselves form a satisfactory guide to the true position. A train may be empty or full, or an accident, perhaps not at all serious in itself, may be made so by the chance circumstance that another train is immediately at hand on an adjacent line and cannot be stopped in time. The fact that several accidents have taken place within a few days has not necessarily any particular significance. In five weeks in 1947 there were four passenger train collisions on one railway alone, all of them fatal and one very much so, with another a month later, and yet in the preceding 20 years only nine fatal accidents had been recorded on that line.

Safe operation of railway traffic involves many factors and correspondingly numerous sources of possible mishap. Its human and technical aspects are so closely interconnected that although much can be—and long has been—done to provide reasonable safeguards, in the form of good signalling and other equipment, against at least the more serious classes of mistake, much reliance still has to be placed on sound training of the staff and the intelligent and conscientious performance of duty. Without them the purpose of even well-tried apparatus can be defeated, as one at least of the recent cases has shown. It would not be possible economically, even if all the technical requirements could be met, to provide complete protection against every conceivable contingency. There will always be some risk to the passenger. For many years in Great Britain this risk has been extremely small. In 1954 not a single passenger lost his life in a "train accident"—a condition which obtained in 1901, 1908 and 1949—among 1,566 million passenger journeys, while the fatalities to anyone whatever were the lowest ever known—0·5 per million train-miles.

In his annual report for that year the Chief Inspecting Officer of Railways, Lieut.-Colonel G. R. S. Wilson, showed that in practically every respect continuous improvement was being recorded, although there was a small increase in "train accidents" over the previous year. Of the 1,197 cases, however, many were but trifling incidents and eight only were considered to call for a formal inquiry. One involved the failure of electrically-operated facing points, which might have had grave consequences. It arose, however, from a most unusual combination of circumstances, the recurrence of which need not be feared. Even so, the case taught a valuable lesson, as did some other failures of equipment, such as that which caused the derailment in Watford tunnel, where an unusual series of rail breakages had been experienced. Labour shortage had contributed to difficulties in maintenance, but research is being undertaken into the whole question, and rail welding is being extended to tunnels to eliminate joints entirely. No opportunity is lost of profiting from the experience of accidents, though much time often is needed to carry through the improvements seen to be desirable. The extension of continuous track circuiting and colour-light signalling, a large programme of which is envisaged, will increase the level of safety.

The difficulty of obtaining the right class of man, however, presents some problems. There have been some disturbing cases of careless and inexcusable conduct in signal-boxes. As an instance of the great value of modern signalling methods it may be mentioned that at the London Bridge, Waterloo and Victoria stations of the Southern Region over 3,000 electric trains, with numerous steam passenger, goods and parcels trains, are dealt with daily, and that in the last 20 years only three official inquiries into accidents at those stations have been necessary and there has been only one passenger fatality. Yet there are no automatic train stop or train control devices in those areas and very close clearances have to be worked to, in order to handle the peak traffic movements efficiently. On the main express routes, however, still principally operated by steam, other problems present themselves, particularly in bad weather, and the installation of a general system of warning automatic train control, as envisaged by the British Transport Commission and mentioned in our issue of last week, could be expected to bring some increase in the level of safety. This system includes a visual indicator for reminding the driver that he has silenced his warning hooter—an improvement over some earlier equipment with which it is possible to forget that a warning has been acknowledged, as appears to have been the case recently at Didcot.

There has been for some years a progressive decline in the accidents arising from failure to obey signals, and of the 51 cases in 1954, 13 probably would have been prevented if this apparatus had been in use. While therefore recent accidents may have presented some disquieting features from the point of view of staff intelligence and discipline, there is no ground for thinking that the safety record of British Railways will not remain at a high level nor the improvement since the war cease to be noticeable.

Weekly Survey

Cover Picture: *During the second World War, magnetic mines were one of the hazards for shipping. The answer to them was found in de-Gaussing equipment which was devised to counteract the effect of the ship's field on the mine. The photograph shows part of this equipment during construction.*

★ ★ ★

The American Boom

The prospect of a continuing boom in the United States and Canada is received by engineering companies with mixed feelings. On the one hand it means the probability of a prosperous industrial environment, especially, but by no means exclusively, for exports to North American markets. On the other hand, it is likely to mean very firm prices for imported industrial raw materials—and manufacturers' problems of forecasting the trend of their own costs are already bedevilled by high raw material costs.

There have been a number of authoritative forecasts made recently about the possible duration of the latest boom in the United States, which will favourably affect Canada as well. O.E.E.C. have now gone on record with a pamphlet on economic conditions in Canada and the United States which broadly follows recent informed opinion on the subject.

The present boom was borne mainly of a big extension in residential construction and a marked increase in consumers' expenditure. This gave rise to a reversal of the tendency to reduce inventories, which was followed by an actual increase in inventories and later by large-scale capital investment. It is expected that the tendency towards higher wages and employment will continue to stimulate the demand for consumer goods and that a further increase in private fixed investment will also develop.

Since the report was published there has been one important restraining factor introduced into the situation, namely the announcement by the president of the General Motors Corporation that U.S. automobile output will be smaller in 1956 than in 1955. This drop could be exceedingly serious if it gathered momentum, for no single industry in the United States transmits the consequences of its production policy more quickly or widely than the automobile industry.

In the case of Canada, expansion from the 1953 recession is expected to carry on though at a more modest rate than in 1954 and 1955. Some concern is expressed in the report about the need to gear the extension of Canadian manufacturing capacity to the inflow of immigrants. The report thus considers the outlook in Canada to be generally favourable. This is probably the case, especially when account is taken of the excellent long-term prospects for Canadian minerals and oil. The O.E.E.C. report, however, abruptly discounts the recent difficulties which farmers in the wheat belt of the prairie provinces have undergone in the last 18 months. It would, in fact, be something new in the economic history of Canada if it could absorb a drop in farmers' income without a serious, if temporary, check to its long-term expansion.

★ ★ ★

A Question of 15 Per Cent.

After a two-hour meeting with the Engineering and Allied Employers National Federation, the Confederation of Shipbuilding and Engineering Unions succumbed to the request of Sir Percy Mills, the chairman of the employers federation, to present a concrete demand for a wage increase to the meeting. The union representatives held further discussions among themselves at which it was quite clear a difference of opinion among them had to be ironed out as to whether they should demand a 10 or 15 per cent. increase, and they finally took up the rather obvious bargaining position of 15 per cent.

The employers, who are highly sensitive to the pressure of costs, have already pointed out the strain which the industry will have to endure if a bill approximating to £150 million a year is added to its expenditure. This is a bitter prospect for many companies which are now heavily committed in the export market (partly in response to official cajoling and pressure) and for the many small concerns which have little prospect of weathering a short-term blizzard with ample financial resources or of offsetting high labour costs in the long run by heavy capital expenditure. Mr. Openshaw, for the unions, justified the claim on the grounds of the industry's prosperity, increased productivity and rising cost of living.

There is space this week only to draw attention briefly to the anomalies in these arguments. On the first score, that of prosperity, there is a good case in principle but the details should be argued from a clear conception of what are the net profits being earned by the average concern in the industry, not by some conception of gross profits which is convenient to the trade unions to choose for the purpose of the negotiations. So far as productivity is concerned, the position is certainly vague and the unions' claims definitely exaggerated. If it can be assumed that the wage agreement last March represented something approaching justice, it could be said that the case so far as it depends on increased productivity and the high cost of living rests on what has happened since last March. Unfortunately, no figures are available for the period March to December, 1955, but a glance at the position between December, 1954, and June, 1955, suggests that the productivity argument is being overworked. Between December and June, employment in the engineering industry went up by about 1·9 per cent., and output by about 6·5 per cent. Productivity could not, therefore, have increased by much more than 4 to 4½ per cent.

So far as the cost of living is concerned, between March and November of 1955 the official retail price index increased by 5½ per cent., and by 3 per cent. between March and October. If the unions were considering demanding 10 per cent. before the Budget, this presumably was made up of 3 per cent. cost of living, about 4 per cent. productivity and 3 per cent. prosperity. Although these kinds of figures are crude approximations, they are an arguable proposition to work from, but they make 15 per cent. look exceedingly unconvincing.

★ ★ ★

Britannia and Comet

With the delivery of the first two Britannia air-liners to the British Overseas Airways Corporation on Friday last—only a few hours after the Bristol Aeroplane Company, Limited, had received the Certificate of Airworthiness—B.O.A.C. have great hopes of a new era of prosperity; the successful conclusion of the Comet 3 route-proving flight over Commonwealth routes is an advance towards the re-entry of the Comet into airline service in 1957. It is of interest to note that, in order to simulate the increased drag of the Comet 4 which will result from its higher weight, the Comet 3 was flown on its round-the-world flight with flaps lowered 3 deg.

The Britannia air-liners, claimed to be the most intensively tested yet flown, have completed 2,700 flying hours; one of the two delivered last Friday has flown 75,000 miles in a 250-hour route-proving programme extending over 42 days, and an airframe has completed satisfactorily 20,000 simulated flying hours in the first phase of pressure-fatigue testing in the water tank at Farnborough. The further continuation of the tank tests should enable any possible deterioration to be detected long before the aircraft in service have accumulated a dangerous number of stress repetitions.

The standard of comfort in the Britannia air-liner, which we were able to sample for ourselves in the spacious 54-seater on the delivery flight, is high; and those who travelled on the 96-seat tourist version reported that the seating was surprisingly comfortable and roomy. It is expected to have a strong appeal to passengers. The quietness and smoothness of the propeller-turbine machine—good though they are—are not pre-eminent; piston-engine aircraft also exist which can offer a low level of cabin vibration. Nor does the propeller-turbine compare with the turbojet air-liner in this respect. We had the opportunity of flying in the de Havilland Comet 3 air-liner the day before the Britannia flight; the Comet's manufacturers state frankly that they are not satisfied with the cabin noise level resulting from the air-conditioning system, only partially developed, and that this will be greatly improved in the Comet 4 when it takes the air in 1957. Nevertheless, we found this the most pleasurable flight that we have yet taken part in, and have no doubt that, where money is no object, future passengers will gladly pay higher fares for the joy of turbojet travel. The importance of the propeller-turbine air-liner lies in its flexibility of operation and in the high pay load which it can carry by virtue of the light weight of the engine installation, as compared with the piston engine, plus a lower fuel load than is possible with the turbojet. Thus it affords economy in operation with a reasonably high cruising speed—approximately 375 m.p.h. in the Britannia.

For the first few months of this year, B.O.A.C. plan to continue their flying training over future routes to be served by the Britannia fleet. By midsummer, when more Britannias will have been delivered, they hope to be in operation on the Johannesburg route. Subsequently, Britannias will fly to Australia, to the Far East, and Colombo.

★ ★ ★

Selling Abroad—Italian Style

The Vanoni Plan for Italy has been sharply criticised on the grounds that little is being done by the Italian Government to implement its aims. Certainly the achievement of the Società Finanziaria Meccanica (Finmeccanica) is not ascribed by its directors to any encouragement from the Government.

How far the private sector of the Italian economy has contributed to the rise in the national income this year is shown in the report of the Finmeccanica group. This association of companies is one of the biggest industrial groupings in Italy, owning more than 50 plants, employing 70,000 workers, and comprising 30 constituent companies, including such names as Alfa Romeo, Fabbrica Macchine Industriali and Maroni Italiana. A large degree of the success which the group enjoyed over the past year is attributed to its intensive and sustained effort in the overseas market.

This achievement was spread over a large field. The flow of shipping orders, for example, which recovered vigorously following the Tamboni Act of 1954, was considerably strengthened by large orders from overseas companies " among which the Esso Group and British Petroleum figured prominently." Production of railway equipment, which for Italy as a whole is currently running below pre-war levels, received a fillip from large overseas orders, particularly from Asiatic countries. "The Finmeccanica Group managed to secure outstanding orders from Indian Railways for electric trains and steam engines, after a long struggle and against vigorous competition from leading foreign concerns." Again, there is a crisis in the Italian textile industry. Finmeccanica solved the problem of selling textile machinery by securing large orders from Iran. Alfa Romeo, a subsidiary of the group, have been complimented in the report on their successful selling policy in Brazil, where an agreement had been reached with the Fabrica Nacional de Motores for the supply of lorries and components for assembly.

How has this been done? First and foremost,

direct representation. Finmeccanica have its own representatives in New York, Mexico Rio de Janeiro, Buenos Aires, New Delhi, Tokyo and Madrid, while the group's constituent companies are represented individually throughout the world. Second, the group has achieved considerable success by co-operation. In the field of trolleybuses, for instance, the group secured large orders in South America in co-operation with other Italian companies. Hunting in packs clearly brings results. It is a stratagem that even the lion does not disdain on occasion.

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Standstill Prices

The undertaking by the cement and plasterboard industries just before Christmas to stabilise their prices until at least the end of June, 1956, has aroused a good deal of comment. The object of these industries is praiseworthy. They have seen, as other industries have seen, that continuing upward pressure of costs is bound to lead to a continuing inflationary situation—the vicious spiral which has become a term current in everyday conversation. They see, too, that it is necessary for someone somewhere to try to give a lead in stopping price increases as opposed to merely talking about it. They recall, no doubt, that Sir Stafford Cripps was able to persuade the unions and shareholders to take the initiative for a short period of time in 1948 and that there is not the slightest likelihood of the unions taking the initiative again. They have set an example, at some risk to themselves, which they hope others will follow.

This move is a gesture and should be examined as such. It is quite true that conditions vary enormously between different industries and that those, such as cement, whose costs are conditioned very much by the prices charged for fuel, power and transport by nationalised undertakings, are not in the same position as industries which are at the mercy of the prices of certain raw materials such as copper and raw cotton. It is true that these last industries may not be able to hold their prices with the same confidence as those whose costs are mainly conditioned by the prices of indigenous materials, but this fact is rather beside the point.

There is a flavour of William Pitt about the situation—the cement and plasterboard industries hope that they will save themselves by their exertions and the rest of industry by their example. Certain it is that if the recent overtures from the British Employers' Confederation to the Trades Union Congress about joint discussions (along with representatives of the nationalised industries and the Government), are to lead anywhere except to pious generalisations, gestures like this one on prices from men who have to handle the problem of making and selling goods for competitive markets, are necessary. It is possible that courage and a good example could succeed where ponderous resolutions are failing.

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Two Steel Companies

By coincidence, news is published in this last week of the recent progress of both Colvilles, Limited, and of Dorman, Long & Co. Ltd. Both these concerns have been going ahead with development schemes and progress reports, from them are of great interest to the engineering industry at present. Colvilles occupy an outstanding position in the steel-plate industry, and the shipbuilding boom now gathering impetus is likely to offer them unique opportunities in the next year or two. Dorman Long, with a wide range of interests in steel and structural engineering, are pre-eminent in structural steels and plate for shipbuilding. At Lackenby, their new universal beam mill is expected to produce 80,000 tons a year of universal beams and normal or standard heavy sections. This new range of universal beams, to be produced in this country for the first time, is expected to make a big contribution to high productivity and efficiency in structural engineering.

Colvilles' directors report for the year ended September, 1955, tells laconically of continued progress despite transport delays due to strikes. Steel ingots and castings produced increased by 2 per cent. on the year to what must be a new record level. Progress at the Ravenscraig works (where an integrated steel works to supply newly modernised rolling mills is going up) is satisfactory. Electrification of the Motherwell plate mill is complete and other electrification schemes in the group have been prepared. Here, altogether, is a fitting culmination to Sir John Craig's work as chairman and managing director after 67 years with the company. He is to become honorary president of the company by a resolution to be presented at the next annual general meeting.

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Gas-Turbine Locomotives

The recent decision in America to build 45 more gas-turbine-electric locomotives for the Union Pacific Railroad suggests that the position of the Diesel locomotive is not unassailable. The Union Pacific ordered ten 4,500 h.p. gas-turbine-electric locomotives in 1951 and these were sufficiently successful in service for a further fifteen to be ordered from the General Electric Company in 1953. They, too, fulfilled expectations; they were, in fact, handling about one-tenth of the railroad's gross ton-mileage.

Though these engines have been in traffic a sufficient length of time to establish fuel costs—which are believed to be approximately similar to those of a Diesel-electric locomotive—it will not yet have been possible to ascertain the full maintenance costs. The additional 45 gas-turbine-electric locomotives now to be built are of greatly increased size—no less than 8,500 h.p. The total cost will exceed 38 million dollars. As, however, the capital cost per horse-power differs little from that of a Diesel-electric, the maintenance costs will clearly be a deciding factor. Work on the first 15 is already authorised and the remaining 30 will be built later.

Brief technical particulars have been announced. The locomotives will be the most powerful internally-powered units (as distinct from electric) ever to be built. Each will consist of two sections and a tender. The object of employing a separate tender is to avoid fluctuations of the adhesive weight; 24,000 gallons of fuel will be carried, heated pior to loading and kept warm by insulating the tender. Delivery of the locomotives, at a rate of two per month, is to commence in 18 months' time. Geared for freight service they will have a top speed of 65 m.p.h. and weigh 408 tons distributed over 12 axles. Length overall, including tender, will exceed 165 ft.

It is apparently the long steep hauls of heavy freight trains on the Union Pacific which favour the use of large gas-turbine locomotives. The same conditions do not obtain on British Railways, though it is conceivable that further developments in the design of gas-turbine locomotives might alter the balance in the future. The General Electric Company of America report that the gas-turbine locomotives already in service had run 5,306,511 miles and 219,650 hours by November 17 last. If similar gas-turbine engines in other than locomotive applications are included, the total service hours on that date were 922,934.

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Cheaper Industrial Buildings

A survey is to be undertaken by the Building Research Station under the auspices of the Midland Regional Board for Industry into the best types of industrial buildings from the point of view of design, materials and operating costs. This survey will be the first of its kind and it is clearly of considerable importance to industry at a time when the capital outlay per unit of floor space for factory extensions and new buildings is becoming more onerous and a large factory programme is being undertaken by the economy at large.

The Board noticed about two years ago that as a result of work undertaken by the Building Research Station the cost of erecting schools had fallen since 1949 by 50 per cent., while 82 per cent. of school space was available for teaching purposes compared with 35 per cent. in 1947 and 1948. The Board has been impressed by the fact that although there has been this significant improvement in the layout of new schools (a development which has been common throughout the country in the last 10 years), no body of data or proven architectural practice has been assembled which would enable the successful work on schools to be applied to other forms of building. In particular, no authoritative data are available to industry on factory design and building materials or on the comparative operating costs of different kinds of building; for example, the comparative merits from every point of view of single as opposed to multi-storey buildings.

The chairman of the Board pointed out recently that large differences in cost existed between different types of roofing for single-storey buildings but little collated information existed as to which was the best or cheapest under differing conditions. A good deal of information existed as well on ventilation and heating which could usefully be compiled in a readily available form. It seemed likely that an investigation might show that there was a good deal of common ground among the requirements of dissimilar industries so far as factory space was concerned. If this should be so, there would clearly be a basis on which useful standardisation could be achieved and the lengthy and costly delays in design and construction work of factories reduced accordingly.

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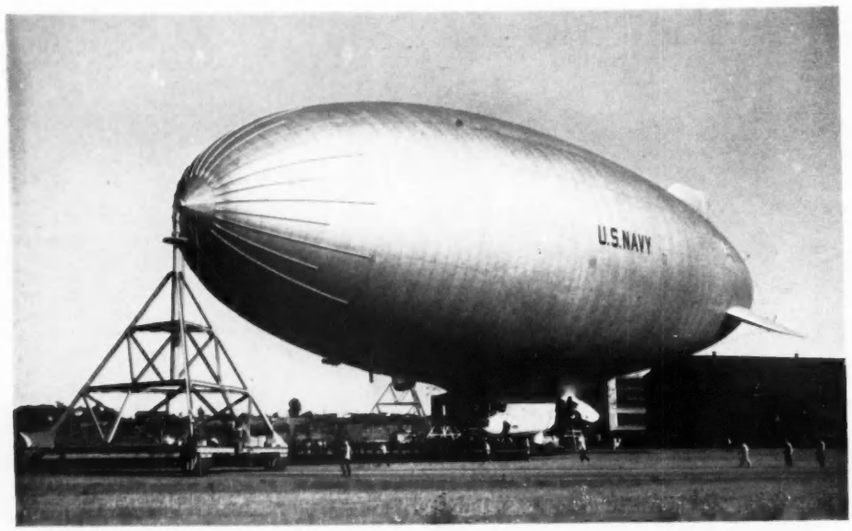
Something for Nothing is too Expensive

It is curious how the official mind operates. For months, even for years, there has come directive after directive, appeal after appeal in the two battles now being waged—those against smog and the waste of fuel. Special grates have been designed which are said to burn coal or smokeless fuel more efficiently, to give out more heat and less smoke. Some of the claims made have been questioned, but financial assistance is available to the householder who lives in a " smokeless " zone and desires to fit one of these appliances. A most commendable plan, but the fact remains that the domestic boiler is still one of the major producers of smog—and carries no purchase tax. Yet electrical heating apparatus carries a very heavy tax—althougn it cannot possibly produce any smog and is one of the most efficient methods of converting energy into heat.

A particular case in point is the domestic heat pump which fulfils the double purpose of refrigerator and water heater. Two such units have been described in ENGINEERING, (vol. 179, pages 47 and 381, 1955). If the ordinary electric heater converts energy to heat efficiently, what of those appliances which give out three times more heat than is supplied to them in the electricity they consume? Yet they are subject to a 50 per cent. tax, although figures are available to show that such a unit can save as much as 1½ tons of fuel a year as compared with a boiler. A small amount perhaps—but how many homes are there in the country? How many householders would like to reduce their fuel bill by £10 or £12 a year—and have constant hot water and refrigeration? In less than two years more than a thousand units have been sold by two firms, yet so crippling is the tax that one firm has been forced to abandon production, an action affecting both home and export markets.



The Goodyear ZS2G 600,000 cub. ft. submarine-search airship on her mooring mast. This airship, the latest modification to the K-class, has better speed and endurance and more manoeuvrability than any airship so far designed.

AMERICAN NAVAL AIRSHIPS

LONG-RANGE CONVOY AND SUBMARINE SEARCH

The superiority of the airship over aircraft of the heavier-than-air type for searching out submarines was the principal point of a lecture on the use of airships by the United States Navy, given recently before the Royal Aeronautical Society in London by Lord Ventry. In the earlier part of his lecture Lord Ventry traced the history of the military airship in the United States from the inception of the American Naval Airship Service in 1916 *to the end of the second World War, during which* 134 *K-class and* 4 *M-class non-rigid airships were built by the Goodyear Company—sole producers of airships in the United States since about* 1924. *These airships were equipped with a large amount of detection gear, carried out a total of* 550,000 *hours flying, and escorted* 89,000 *ships without loss. We give below an abridged version of the later part of the lecture in which the lecturer discussed the development of the non-rigid naval airship since the end of the second World War.*

At present there are five to six squadrons of naval airships in the United States. About half of the total number of airships are working with the Atlantic fleet. Expeditionary bases with mooring masts are organised whenever airships are needed on Fleet exercises. The mast has made airships extremely mobile, as no runways and elaborate fog landing facilities are needed.

New and larger versions of the K-ships—the ZSG/4—which were the backbone of the airship service during the War, are being developed. They can land on carriers and so change their crews. They are quickly re-fuelled from tankers, and can pick up ballast from the sea. Such airships have great powers of endurance. Another improved model, the ZS2G, is about 600,000 cub. ft. in capacity. She has a better speed and endurance and more manoeuvrability than any airship so far designed specifically for anti-submarine warfare.

The most interesting airships that are being produced to-day are the very large non-rigids of the ZPG-class, earlier known as the N-class, for long-endurance patrols. These airships are of 975,000 to 1,000,000 cub. ft. capacity and are driven by two Wright Cyclone engines giving a total of 1,400 h.p. Unlike all the other airships which have outrigged engines, these engines are placed inside the lower deck of the 80 ft. car in engine rooms. The three-blade Curtiss 18 ft. diameter propellers, therefore, are driven by shafts through gears. They can be fully feathered and are reversible, as indeed are all the later K-class airship propellers. These airships carry the biggest load of electronic detection gear that any aircraft so far have taken aloft, and at the same time they have proved capable of flights of very long duration. The N2, for example, when carrying out a submarine exercise, was in the air for just over 200 hours, a record for flight without re-fuelling. These airships also can be re-fuelled and ballasted while in the air.

As early-warning aircraft, American airships carry radar not only under the car but 75 ft. above the car on the top of the envelope. The first of these ships has been delivered, the ZPG.ZW.

LIGHT STRONG ENVELOPES

The success of these very large non-rigids is largely due to the lighter and stronger fabrics now available. Problems of slinging short cars close to a long envelope have also been solved. The car suspension is mainly internal, the cars being slung by steel cables from catenary curtains inside the envelope. There is also a secondary system of suspension attached to the outside of the envelope, but this is faired in and cannot be seen from the ground. The car is also faired into the envelope, so that car and envelope form one unit. The loads are so well distributed that there is no deformation of the envelope, even with the comparatively short cars of the K-class airships.

Envelopes made of nylon and Neoprene are, being tested. This should result in less weight and a longer life. The present day cotton and Neoprene two and three-ply envelopes have a life of from 3 to 5 years on the average. They have better gas holding qualities than ever before.

AUTOMATIC CONTROL OF HELIUM PRESSURE

All the airships are twin-engined and, with the exception of the N-class, the engines are outrigged. The sides of the car let down to form walking ways for the engineers. Breakdowns are almost unknown. Pressure control is now completely automatic in the newest craft, which have at least four ballonets.

Air is supplied to the ballonets from the propeller slipstream in the L and G-ships through metal airscoops, which cannot be raised. In the larger ships the airscoops are built into the engine bearers. In addition, the K-ships and larger types have electric blowers which are only used when landing or in an emergency. Observation domes are fitted and it is possible to look right inside the envelope, even when in the air.

The ships are unattended by a human gas guard. An electric blower is used which is automatically set in motion when the pressure falls too low, and switches itself off when the pressure is again restored to normal.

The fact that all the airships and even free balloons are inflated with helium has made many differences in airship operation.

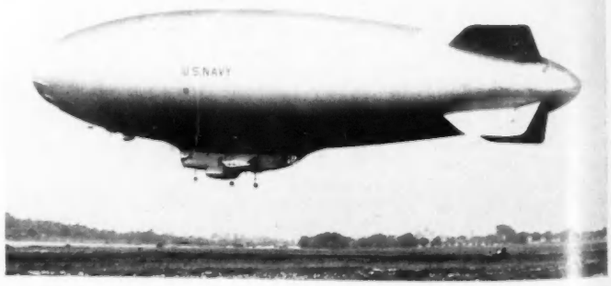
A helium-filled ship can be purged without deflation. When such an airship is deflated the gas can be stored and used again; hence in flight the gas valve is seldom touched, and great care is taken to avoid climbing above pressure height. As the ships can be kept inflated for two or more years this saves much wear and tear, and makes for greater economy.

TAKE-OFF AND LANDING TECHNIQUE

To ensure that an airship does not have to land very light, which would mean valving helium before landing, it leaves the ground like an aeroplane, taking off perhaps 4,000 lb. heavier than air in the case of a K-ship, and 6,000 lb. or more in the case of an N-ship, all depending on the length of the proposed flight. By the time it is due to land, sufficient fuel has been used to bring it more into equilibrium.

When an airship is to leave the shed it is first ballasted up and then attached to a short transportable mast. The tractors then drive the ship out and in normal weather very few men are on the guys at all, the stern guys only being manned. On leaving the mast, these hands move over to the bow guys. The engines are "revved" up and the ship gathers way. This habit of taking off heavy like aeroplanes has had an effect on fin design. With the older cruciform planes there was some danger of the bottom plane hitting the ground when taking off. The N class ships have four fins set at an angle of 45 deg. to one another, and the rudders and elevators are known as "rudevators" for they act in unison and serve both purposes.

Snow, however, is apt to lie between the two



The Goodyear ZPG-2 airship, with a capacity of 975,000 cub. ft., holds the endurance record of just over 200 hours flight without re-fuelling. She can, however, be re-fuelled and re-ballasted in the air.

fins, and to get over this difficulty the latest of the K modifications has three fins, one vertical and two side fins set at 45 deg. It is stated that this airship is one of the most controllable that has yet been built.

When conditions are suitable, the airships land on the wheel and taxi up to the landing party. Once on the ground the mooring mast is brought up to the airship with a man standing on the mooring platform and in a matter of moments the mooring pennant on the airship's bow is attached to the mast wire and the airship's cone is soon locked into the receiving arm on top of the mooring mast. Once on the mast, the car pivots on its wheel, and the airship keeps into the wind.

A new type of aluminium portable mast has been developed, which is flown ahead of an airship and can be erected or dismantled in two hours. Ballast tanks for water or sand form its base. All masts are towed by tractors and the airships always enter and leave a shed and are manoeuvred on the landing ground when on the mooring mast.

Experimental "mules" are now being developed which show great promise for docking and undocking, masting and unmasting for take-offs and landings, with quick-disconnecting devices on the cables for take-offs, and quick-connection devices for landings. The mules weigh about 37,000 lb. and have a four-wheel drive and four-wheel steering for flexibility. They can be used on any surface including sand, and are capable of withstanding 16,000 lb. tension. The turning radius is within the length of the mule itself and their top speed is 32 m.p.h.

The airships of to-day can enter and leave their sheds while on the mast in cross winds of up to 30 m.p.h. The airships have been moored out in winds of up to 76 m.p.h. without damage.

AIRSHIPS MORE EFECTIVE FOR SUBMARINE SEARCH

The U.S. Navy are continuing to use airships because comparative tests have shown that an airship is more likely to find a submarine than the faster heavier-than-air craft. The airship has a great advantage where prolonged searches have to be made, and where convoys have to be escorted. It is the only aircraft which can, if necessary, keep station with a convoy for days on end. It is the only aircraft which can carry a really complete load of electronic detection gear, and yet carry a large enough crew to make full use of it all. The large roomy cars also make for operational efficiency as the crews can work under good conditions. The cost per airship-operating hour is stated to be about 10 dols. as compared with an average cost of more than 50 dols. for other patrol types.

As the underwater range and speed of the submarine have improved, it can now operate out of range of its own heavier-than-air craft. Shipping can be attacked in distant parts of the ocean. Thus, the airship can do a useful work escorting convoys and looking for submarines, well out of range of hostile air attack. The airship has little to fear from the submarine, if it is co-operating with warships and near a convoy, as no submarine to date has surfaced to attack an airship under such conditions. In fact, Admiral Doenetz is stated to have admitted that the German U-boats could not really cope with what he called the "Little Zeppelins" of the U.S. Navy.

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CENTENARY OF "THE ENGINEER"

To celebrate the centenary of the founding of *The Engineer*, the first issue of which was published on January 4, 1856, a dinner for the editors of technical journals was held at the Savoy Hotel, London, on December 20. Mr. B. W. Pendred, Editor of *The Engineer*, presided and 60 editors attended. Mr. F. B. Roberts, Editor of ENGINEERING, proposed the toast of "*The Engineer*." An article on this page and the leading article in our issue of December 30 make reference to the centenary.

ENGINEERING CENTENARIES OF 1956

When, on January 8, 1856, Robert Stephenson delivered his presidential address to the Institution of Civil Engineers, he chose as his subject "Our British Railways," because "the present stagnation in engineering matters precludes my treating of the few works in actual progress." So far as major works of civil engineering were concerned, this was broadly true, for the country had been engaged for two years in the Crimean War (which did not end until April, 1856) and much productive effort was diverted to that cause; but in other respects events were in progress which made the year one of some note. In his own field of railway engineering, apart from the opening on June 3 of the 10-acre Swainson Dock at West Hartlepool and on July 8 of a railway from Darlington to Barnard Castle, the Stockton and Darlington Railway completed in September a branch from Shildon to West Auckland which enabled them to abandon the use of their Brusselton incline, the remains of which still attract railway historians to its site.

INTERLOCKING SIGNALLING

Much more important, however, than these and the several other relatively minor extensions to the British railway system was the introduction in 1856 by John Saxby (1821–1913) of the interlocking of points and signals. Saxby, a carpenter by training, was the London, Brighton and South Coast Railway's foreman of carpenters, joiners and associated tradesmen at their Brighton works when he took out his patent for interlocking and it was not until 1861 that he left them to start a works at Hayward's Heath to develop his inventions. The business expanded rapidly and he moved his works to Kilburn, where they remained until 1903, when a further move was made to the present works at Chippenham, Wiltshire. Our obituary notice of Saxby recorded that, in 1844, Charles Hutton Gregory, who had erected the first of all semaphore signals a couple of years before, led the chains from several signals at Bricklayers' Arms to a single frame, so designed that only one signal could be operated at a time; and it was this installation at Bricklayers' Arms which was the first to be converted to the Saxby system. It controlled eight signals and six pairs of points.

While Saxby was thus making railway history on the Brighton line, there died on November 1, 1856, the man who had not only, as resident engineer, constructed that line, but had been almost as prominent a figure as George Stephenson himself in the evolution of the 18,000 miles of British track, involving an estimated 550 million cub. yds. of excavation, to which Robert Stephenson had devoted his presidential address. Nor does this assessment exhaust the claims to attention of John Urpeth Rastrick, for, with John Hazeldine of Bridgnorth, he had built Trevithick's famous "Catch-me-who-can" in 1808—though he did not trouble to journey to London to see it running on its circular track near Euston-square—and in 1829, in association with William Foster of Stourbridge, he built for the Delaware and Hudson Railroad the "Stourbridge Lion," the first locomotive to run in the Western Hemisphere. He was one of the judges at the Rainhill trials of the Liverpool and Manchester Railway in 1829. At his death, at the age of 76, an anonymous obituarist described him as "a Cid of civilisation"; an allusion which was probably lost on most of his engineering contemporaries.

IRON SHIPBUILDING

On the North Atlantic, 1856 was a year of portent, in which the wooden ship suffered a severe blow and iron shipbuilding recorded a significant advance. On January 23, the wood-built paddle steamer Pacific, of the American-owned Collins Line, left Liverpool for New York and disappeared without trace; or, at least, almost without trace, for, a few weeks later, a ship reported passing what appeared to be part of a large wooden paddle-box, which could not be picked up because of heavy seas. The Collins Line had been formed in 1848, to compete with the British and North American Royal Mail Company (which became the Cunard Steamship Company in 1878) and had originally four ships, of which the Pacific was one; but the Arctic was sunk in collision in 1854 with the loss of 322 lives, and the line did not long survive the second disaster, the other ships being withdrawn in January, 1858. Meanwhile, early in 1856, the British and North American company put into service their first iron ship, the Persia, of 3,870 tons, with paddles 40 ft. in diameter driven by side-lever engines with cylinders 100 in. in diameter and 12 ft. stroke. She and her sister Scotia, which went into service six years later, were the last paddle steamers on the "Atlantic Ferry" and were unrivalled in their day; though they had no lack of competitors, for the Anchor Line started to operate in 1856 from Glasgow, which is still its headquarters, the Inman Line were already in the field, and the Allan Line soon followed.

For yet another form of transport 1856 was a significant year, as it saw the appearance of the first mechanically-propelled road haulage vehicle. This was built by Charles Burrell, of Thetford, and was fitted with Boydell's so-called "endless railway" of hinged plates round the rims of the wheels. Boydell's "railway" was not a new invention, having been applied to the wheels of some heavy guns during the Crimean campaign and also to two converted portable engines, one fitted by Richard Bach of Birmingham in 1855 and the other by Richard Garrett and Sons, of Leiston, in 1856; but the Burrell engine was the first to be constructed *ab initio* as a road haulage engine. A movement is on foot, and arrangements are well advanced, to mark this centenary by affixing a tablet to the building wherein the engine was constructed. The firm of Charles Burrell and Sons went into liquidation in 1932, following the collapse of Agricultural and General Engineers, Limited, into which combine they had been absorbed.

BESSEMER'S "WHOLLY DECARBURISED IRON"

Transport was not the only branch of engineering for which 1856 was notable, for the year saw developments of far-reaching importance in iron and steel making. It was on August 13, 1856, that Henry Bessemer read before the British Association in Cheltenham his famous paper on "The Manufacture of Iron without Fuel," under the chairmanship of George Rennie. The discussion was opened by James Nasmyth, who, holding up a small specimen of Bessemer's "wholly decarburised iron," said, "Gentlemen, this is a true British nugget," and declared that he was ready to "go home and tear up my now useless patent" for blowing steam through puddled iron. There were troubles enough in store for Bessemer before he achieved his ultimate success, but Nasmyth had not overstated the case. It was in 1856, too, that Sir William Siemens (1823-83) invented his regenerative furnace, which, like Bessemer's converter, was to exert an influence far beyond the country of its origin; and that William Beardmore, the great Scottish steelmaker, was born.

The improvements in communications which were initiated in 1856 were not confined to transport, for it was in this year that the Atlantic Telegraph Company was formed at the instigation of Cyrus W. Field of New York, and with the collaboration of John (later Sir John) Pender, John Watkins Brett, a wealthy antique dealer, Professor William Thomson (afterwards Lord Kelvin), and, as chief engineer, Charles Tilston Bright, who was subsequently knighted for his part in the laying of the first Atlantic cable. In

America, an important step was taken in the same year in the unification of telegraph systems, when Hiram Sibley linked up a number of struggling telegraph undertakings to form the Western Union Telegraph Company. The wisdom of the move was questioned at the time, one critic commenting acidly that Sibley was merely "collecting all the paupers in the State and arranging them into a union so as to make rich men of them"; but Sibley was right and the company prospered exceedingly—much to the advantage of Samuel F. B. Morse, the telegraph pioneer, who at last was able to reap the reward of his pioneering.

Industrially, there are so many engineering undertakings for which 1856 was the natal year that they can be no more than indicated by a few examples—for instance, Greenwood and Batley, Limited, Leeds; Gilbert Gilkes and Gordon, Limited, Kendal; the Morgan Crucible Company, Limited, London; and possibly Tangyes, Limited, Birmingham, though it is a little difficult to ascertain from Sir Richard Tangye's reminiscences, published in his old age, exactly when he resigned from the service of Thomas Worsdell to set up on his own account.

WATER-TUBE BOILERS

In 1856, moreover, a new industry started—the production of aniline dyes, as the result of the researches of William Henry Perkin (1838–1907), who was knighted for them, but had to wait 50 years for that recognition, until the jubilee of his discovery. In the United States, in 1856, Stephen Wilcox constructed the prototype of the water-tube boilers on which have been built up the great Babcock and Wilcox undertakings in this country, the United States and elsewhere. Except that the tubes were not quite straight, it was substantially the same as the "W.I.F." (wrought-iron front) type which became a standard product for fully 60 years. The centenary of "our esteemed contemporary" for 90 years, *The Engineer*, which appeared for the first time on January 4, 1856, was referred to in last week's issue, but it is not the only one in the world of printing and publishing, for it was in 1856 also that John Walter II of *The Times*, with his Italian collaborator, Dellagana, began the experimental work which resulted in the now-familiar process of stereotyping—exactly 400 years after Johann Gutenberg produced his famous "Mazarin" Bible.

Two scientists whose researches contributed to one end will serve to round off the chronological interest of 1856; though they never met, for the good reasons that one, Count Amadeo Avogadro, died in that year and the other, Sir Joseph John Thomson, was born in it. Avogadro (1776–1856) was Professor of Physics at Vercelli when he enunciated his well-known hypothesis that equal volumes of all gases, at the same temperature and pressure, contain the same number of molecules; he formulated it in 1811, 70 years before the foundation of the Cavendish Chair of Experimental Physics at Cambridge, to which J. J. Thomson added such lustre. Of Thomson's work on the phenomena of electrical discharges through gases, little need be written here; it may well be said of him, as of Sir Christopher Wren, *Si monumentum requiris, circumspice*, for the neon lighting which has transformed the appearance of cities and towns throughout the world is a nightly reminder of his fundamental research.

To go back another century in history is to step into a very different world, but one no less significant in its influence upon the progress of civilisation, and in its links with scientists who have contributed to that progress more recently. It was in 1756 that "Jack" Fuller, founder of the Fullerian professorships at the Royal Institution, was born; he founded them in 1833, the year before he died, the first incumbents being Michael Faraday (chemistry) and Dr. Peter Mark Roget (physiology). In 1756, too, Dr. Joseph Black succeeded as Professor of Chemistry at Glasgow, William Cullen, whose pupil he had been and whose paper "On the Cold Produced by Evaporating Fluids" inspired Black's eventual elucidation of the phenomenon of latent heat; and it was in 1756 that James Watt returned from his short sojourn in London to the Clyde, there to establish his long friendship with Black and to absorb from him the interest in the properties of steam which led to the development of the separate condenser and the enormous improvement which it effected in the generation of power by steam engines.

On August 3, 1756, John Smeaton landed from a small boat on the Eddystone Rock and began to set out the foundations of his Eddystone lighthouse; the third of the four that have been constructed on that most difficult site. The first, Winstanley's, was erected in 1698 but stood for only five years, being swept away in the great storm of November 20, 1703. It was succeeded by Rudyerd's stone tower, completed in 1709, which was destroyed by fire in 1755. Smeaton's lighthouse, being undermined by the sea, was taken down in 1882 and re-erected (except for its base) on Plymouth Hoe as a monument to Smeaton. The present Eddystone lighthouse, completed in 1882, was designed by Sir J. N. Douglass (1826-98), who entered the service of Trinity House in 1856 as resident engineer on the construction of the Smalls lighthouse.

It was in 1756 that Vienna Observatory was founded, though, for want of equipment, little of value emerged from it until it was rebuilt in 1826; and in the same year appeared the first edition of John Ferguson's book on *Astronomy Explained Upon Sir Isaac Newton's Principles*, over which George Stephenson and his son Robert pored before constructing the sundial which is still to be seen over the door of Dial Cottage, in which they lived when George Stephenson was employed at Killingworth Colliery. In 1756, too, was born Lieutenant-Colonel William Lambton, who, with Sir George Everest as his chief assistant, began the Great Trigonometrical Survey of India.

PENDULUM CLOCK

Yet another century back in time brings into the picture one of the world's outstanding scientists. Christiaan Huygens, who in 1656 invented the pendulum clock; and that prince among astronomers, Edmund Halley, who was born in the same year. Halley's Comet is one of the most popularly known of celestial bodies, yet it is perhaps of less importance as a reason for remembering Halley than the fact that it was he who induced Newton to allow his *Principia* to be printed, and who paid for the printing out of his own pocket. It has been said of him, indeed, that if he had done no more than that, he would be "assured of the everlasting gratitude of posterity." In 1656, also, was born Dr. Henry Briggs, who was to become Savilian Professor of Geometry at the University of Oxford; a notable benefactor to engineers, for it was he who so greatly increased the usefulness of logarithms by calculating them to the base 10 and who computed the first extensive logarithmic tables.

The pursuit of engineering and scientific centenaries might well be carried back to Roman or even Egyptian times, though precise dating becomes difficult in the centuries before the Sixteenth; but there is one date in the Sixteenth Century, 1556, which is by way of being an engineering landmark, for it was in that year that there appeared the classic work, *De Re Metallica*, of Georg Landmann, much better known even in these unclassical days by his Latinised name of Georgius Agricola. He did not see its publication, for he had died in the previous year.

In conclusion, a quick return may be made from 1556 to 1856, to record the fact that it was a hundred years ago that the Institution of Mechanical Engineers made institutional history by holding their first Summer Meeting, in Glasgow, under the presidency of Sir Joseph W. Whitworth. It was frankly a recruiting campaign, for the total membership was then little over 200. Few policies have been better justified by the results.

Obituary

SIR RICHARD REDMAYNE, K.C.B.
Doyen of Mining Engineers

The news of the death of Sir Richard Redmayne which occurred in his 91st year on December 27 at his home at Little Hadham, near Bishop's Stortford, Hertfordshire, will be received with regret by civil and mining engineers in many parts of the world.

Richard Augustine Studdert Redmayne, who was a past-President of both the Institution of Civil Engineers and the Institution of Mining and Metallurgy, was the fourth son of the late Mr. John Marriner Redmayne, J.P., and was born at South Dene, Low Fell, County Durham, on July 22, 1865. He was educated privately, and in 1881 entered Durham College of Science. In 1883, at the age of 18, he began a pupilage of

The late Sir Richard Redmayne.

five years under Mr. Thomas Lishman, general manager of the Hetton Collieries, County Durham, and on completing this in 1888 was made under-manager of the Elemore colliery.

In 1891, Redmayne went to Natal, South Africa, to take up the post of general manager of a colliery, but he was later also employed by the Natal Government in exploring and reporting on the oil shales of the Drakensberg Mountains. Returning home in 1893, Redmayne was made resident manager of the Seaton Delaval Collieries, Northumberland, and continued in this capacity until 1902 when he was appointed Professor of Mining in the University of Birmingham. He also undertook consulting work, and during the long vacation of 1906 was commissioned by the Natal Government to explore and report upon the minerals of the Vryheid and Nondweni districts and the desirability of extending the Dundee to Vryheid Railway.

In 1908 Redmayne became the first holder of the newly-created office of H.M. Chief Inspector of Mines and during the subsequent twelve years worked hard in promoting safety in the coal mines, serving on many departmental and other committees on accidents, the use of electricity in mines, the organisation of rescue work, the testing of safety lamps, and similar matters. During the war years from 1916, and until 1920 he was assistant to the Controller of Coal Mines. In 1919, Sir Richard, who had been created a K.C.B. in 1914, relinquished his position as chief inspector to take up that of chairman governor of the Imperial Mineral Resources Bureau. He remained in this office until 1925, after which and until 1935, he served as chairman of the Advisory Council on Minerals to the Imperial Institute.

On leaving the Government service Sir Richard opened a practice as a consulting mining engineer but was also called upon to serve on numerous committees.

Sir Richard, who was an M.Sc.(Birmingham), had been created a C.B. in 1912, two years before the award of a K.C.B. He was made a Chevalier of the Legion of Honour by the French Government in 1918. Sir Richard was elected a member of the Institution of Civil Engineers in 1908 and served as President from 1934 to 1935. He was elected a member of the Institution of Mining and Metallurgy in 1904 and became President in 1916. Sir Richard was first elected President of the Institution of Professional Civil Servants in 1922 and had since been re-elected to the position every year. He was also a Fellow of the Geological Society.

In addition to official and other reports, Sir Richard was the author of several books and of various articles in technical journals.

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MR. H. V. POINTON

Electrical Manufacturing Industry

It is with much regret that we record the death on December 14, 1955, at the early age of 59, of Mr. H. V. Pointon, managing director of ASEA Electric, Limited, in London, since 1949, and for many years previously their general manager and, later, managing director in India and Ceylon. Mr. Pointon had been seriously ill for several months, but was making satisfactory progress when he suffered a relapse from which he did not recover.

Herbert Vincent Pointon was born in London on November 21, 1896, and received his general education at the Central Foundation School. He was apprenticed to the Metropolitan Electric Supply Company, in the motor department of their Moscow-road sub-station, Paddington, and concurrently attended classes in electrical engineering at Battersea Polytechnic. During the 1914–18 war he served in the Royal Engineers, and on demobilisation returned to the Metropolitan Electric Supply Company as shift engineer at their Amberley-road station, Paddington.

In 1920, Pointon joined ASEA Electric, Limited, in their Chancery-lane office, London, as a technical assistant on the commercial side, and, two years later, was made manager of their printing trades department. In that position he made such progress that, in 1925, the firm sent him to India as general manager of their business in India, Burma and Ceylon, with headquarters at Bombay, where he spent the next 24 years and greatly expanded the scope of his company in the territory under his supervision. He returned to England in 1949, as managing director of the English companies of the group, the position which he held for the rest of his life. Under his direction, during the past six years, considerable extensions were made to their works at Walthamstow. His standing in the Swedish electrical manufacturing industry was recognised by the conferment by the King of Sweden, in 1953, of the honour of Knight of the Order of Vasa.

The late Mr. H. V. Pointon.

Throughout his life Pointon was keenly interested in sport, especially boxing and running, in both of which fields, in his younger days, he performed with credit. He was President of the Bombay Amateur Boxing Federation for six years, and was made Honorary Life President on his departure from Bombay in 1949. He was also a magistrate and Justice of the Peace in Bombay; a Member of the Institution of Engineers (India); a Fellow of the Royal Society of Arts; and the senior past-Chairman of the Junior Institution of Engineers, of which he had been a member for 38 years. He was the youngest chairman ever to hold that office; early evidence of the quality of leadership which marked his whole professional career.

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PROFESSOR G. T. R. HILL

The "Pterodactyl" and the Aero-Isoclinic Wing

We record with regret the death of Professor G. T. R. Hill, M.C., M.Sc., M.I.Mech.E., designer of the Pterodactyl tail-less monoplane and inventor of the aero-isoclinic wing incorporated in the Short Sherpa research aircraft. He died in Londonderry on December 26.

Geoffrey Terence Roland Hill was born in 1895 and was educated at University College School, Hampstead, and University College London. His interest in aeronautics began during his schooldays when, with his brother the late Air Chief Marshal Sir Roderic Hill, he constructed model aircraft and designed, built and flew a full-scale glider. In 1914 he obtained a first-class honours degree in engineering, and joined the Royal Aircraft Factory at Farnborough as a graduate apprentice on the technical staff. In 1916 he was commissioned in the Royal Flying Corps and served with 29 Squadron in France. He was awarded the M.C. and attained the rank of captain before he was invalided home in 1917. In 1918 he was in command of the Aerodynamics Flight at the Royal Aircraft Factory, and served also at the Air Ministry.

Captain Hill, as he then was, joined Handley Page Limited as chief test pilot in 1919, and in 1922 he set an international altitude record in the Handley Page W.8 aircraft. In the same year he was awarded a Senior Studentship of the 1851 Exhibition.

The first Pterodactyl swept-back tail-less aircraft, which he designed to reduce the danger of stalling and to improve controllability at low speeds, was built and made its first glides in 1924. The following year it carried out its first powered flight, and Captain Hill was awarded an M.Sc. degree for research. In 1926 he joined Westland Aircraft in order to develop the Pterodactyl further, and he stayed with the company until 1934, when he was appointed to the Kennedy Chair of Mechanical Engineering at University College.

In 1939 he was lent to the Air Ministry for special war work, and in 1942 he was made scientific liaison officer between the United Kingdom and Canada. While still at University College London he served as consulting engineer to Short Brothers and Harland Limited, and to General Aircraft, Limited. He retired from University College in 1948 and went to live in Londonderry, acting as special lecturer to Belfast Technical College.

As a result of his early work on the Pterodactyl, Professor Hill was an authority on the interrelation of the aerodynamic and structural characteristics of the swept-back configuration, and in his capacity of consulting engineer to Short Brothers and Harland Limited he conceived the idea of the aero-isoclinic wing, in which there is no loss of incidence at the wing tips when the wing deflects upwards under air loads. This conception was realised in the Short Sherpa research aircraft which flew for the first time in 1953.

Professor Hill was a gifted speaker of considerable charm, with the faculty of converting a lecture on a complex technical subject into an evening's entertainment. He served on the Aeronautical Research Council and several of its sub-committees, and on the Council of the Royal Aeronautical Society, of which he was president of the Belfast Branch.

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LIEUT.-GENERAL SIR RONALD CHARLES, K.C.B.

A Distinguished Sapper

We regret to record the death of Lieut.-General Sir Ronald Charles, which occurred at Ilminster on Saturday, December 24, at the age of 80. He had had a long and distinguished career in the Army, serving first in the Royal Engineers and subsequently on the staff and as a member of the Army Council.

James Ronald Edmondston Charles was born on June 26, 1875, and was educated at Winchester and at the Royal Military Academy, Woolwich. He was commissioned in the Royal Engineers in 1894, and, as a subaltern, served in the South African War, being twice mentioned in despatches and being awarded the Distinguished Service Order. In 1904 he began a term of service in India.

On the outbreak of the 1914–18 war, he was appointed to the staff of the Indian Corps and took part in many serious engagements in France. After the departure of the Corps from France in 1915, Colonel Charles, as he then was, became Brigadier-General, General Staff, of the XVII Corps and in 1918 was appointed to the command of the 25th Division.

On the conclusion of hostilities he assisted in re-establishing the Staff College at Camberley, where he remained as senior staff officer until 1921. He then returned to India as Director of Staff Duties at Army Headquarters and, after being promoted major-general in 1923, commanded the Waziristan Force in that year. In 1924, he was appointed Commandant of the Royal Military Academy, Woolwich, but two years later became Director of Military Operations at the War Office. He served as Master General of the Ordnance and Fourth Military Member of the Army Council from 1931 to 1934.

On retirement from the Army he took up an appointment with the British Aluminium Company and, after the outbreak of the 1939–45 war, was for a short time Director of the Foreign Publicity Division of the Ministry of Information. He was Colonel-Commandant, Royal Engineers from 1931 to 1946; Colonel, Bengal Sappers and Miners from 1904 to 1945, and Chief Royal Engineer from 1940 to 1946.

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We also regret to record the deaths of:

MR. ANTONY BLAIR OWEN, B.Sc.(Eng.)(Lond.), at a Reading nursing home on December 17 at the age of 41. He was extrusion manager and assistant production manager at the Banbury Works, Oxfordshire, of the Northern Aluminium Co. Ltd.

MR. CHARLES AUGUSTUS HASPEL, at Duffield, near Derby, on December 18 at the age of 46. He was a former director of Perkins Clean Milk Equipment Ltd., dairy and refrigeration engineers, Derby. From 1947 until 1950 he served as a member of the National Council of the Institution of British Agricultural Engineers.

MR. LESLIE BENJAMIN MARSHALL, A.M.I.E.E., A.M.I.Struct.E., on December 19, 1955, at the age of 56. He had been sub-area engineer of the North Western Electricity Board's No. 6 (Lakeland) sub-area since March 1, 1954.

MR. SYDNEY GEORGE STARLING, B.Sc., A.R.C.Sc., F.Inst.P., on December 16, 1955, at the age of 82. Mr. Starling obtained the Associateship of the Royal College of Science with a First in physics in 1893 and was for many years head of the Physics Department at the Municipal College, West Ham, retiring in 1932. He was a Founder Fellow of the Institute of Physics. Mr. Starling will long be remembered for his text-books. With Mr. J. Duncan he was the author of *A Text Book of Physics for the Use of Students of Science and Engineering*. He also wrote *Electricity and Magnetism for Advanced Students*, *Introduction to Technical Electricity* and other books.

PERSONAL

SIR JOHN CRAIG, C.B.E., D.L., is relinquishing his positions of chairman and managing director of Colvilles Ltd., Glasgow, after 67 years of service with the firm.

Having reached 70 years of age COLONEL J. B. NEILSON, C.M.G., D.S.O., relinquished his seat on the boards of Vickers Ltd., and the Metropolitan-Cammell Carriage and Wagon Co. Ltd., on December 31, 1955. SIR ARCHIBALD J. BOYD succeeded Colonel Neilson as chairman of the Metropolitan-Cammell Carriage and Wagon Co. on January 1.

MR. W. R. JONES, managing director of George Clark and North Eastern Marine (Sunderland) Ltd., has been elected a director of the parent company, Richardsons, Westgarth & Co. Ltd., with effect from December 14, 1955.

SIR ERNEST LEVER, chairman, Richard Thomas & Baldwins Ltd., succeeded MR. A. G. STEWART, chairman and general managing director, Stewarts and Lloyds Ltd., as President of the British Iron and Steel Federation, Steel House, Tothill-street, London, S.W.1, on January 1. SIR ANDREW MCCANCE, D.L., D.Sc., A.R.S.M., F.R.S., deputy chairman and joint managing director, Colvilles Ltd., has been appointed President-elect of the Federation for 1956.

SIR DOUGLAS RITCHIE, M.C., and MR. F. A. POPE, C.I.E., have relinquished their membership of the Ports Efficiency Committee, which meets under the chairmanship of SIR ERNEST H. MURRANT, K.C.M.G., M.B.E. The Minister of Transport and Civil Aviation has appointed three new members of the Committee, namely, SIR ROBERT LETCH, SIR ERIC MILLBOURN, C.M.G., and MR. LESLIE E. FORD, O.B.E.

SIR GUILDHAUME MYRDDIN-EVANS, K.C.M.G., C.B., a deputy secretary of the Ministry of Labour and National Service, has been appointed to be, in addition, chief international labour adviser to H.M. Government. The post of chief industrial commissioner, held by SIR WILFRED NEDEN, C.B., C.B.E., has been upgraded to a level equivalent to that of deputy secretary.

MR. HARRY WHARTON, now 88 years of age, has retired from the position of chairman of the Wharton Crane and Hoist Co. Ltd., Station-road, Reddish, near Stockport, Cheshire, which firm he founded in 1906. MR. HAROLD SMITH, who has been with the firm for 30 years, has been appointed chairman and managing director.

The Ministry of Supply announce that MR. J. HANSON, B.Sc., D.I.C., F.R.Ae.S., at present chief superintendent of the Aeroplane and Armament Experimental Establishment at Boscombe Down, has been appointed deputy chief scientific officer, structures department, Royal Aircraft Establishment, Farnborough. MR. D. E. MORRIS, B.Sc., A.F.R.Ae.S., has been promoted to the rank of deputy chief scientific officer and will succeed Mr. Hanson as chief superintendent at the Aeroplane and Armament Experimental Establishment. DR. B. G. DICKINS, C.B.E., A.R.C.Sc., D.I.C., has been appointed director of guided weapons research and development.

The Mond Nickel Co. Ltd. announce that MR. F. B. HOWARD-WHITE, M.C., has been appointed a member of the Mond Delegate Board with effect from December 21, 1955. In May, 1955, he was elected a director of Henry Wiggin & Co. Ltd.

MR. D. A. STRACHAN has been appointed to the head office of the General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2, and will be responsible for flameproof and mining equipment sales. MR. S. C. WELLS has been appointed to take responsibility for oil-industry equipment sales.

MR. E. R. PERRY, D.F.C., A.I.M., has been appointed a development officer in the platinum-metals division of the development and research department of the Mond Nickel Co. Ltd., at Acton. He took up his duties on January 2.

MR. H. L. EVANS has been elected chairman of the Lead Development Association with effect from January 1. He has succeeded MR. H. A. SEWELL, who has relinquished the appointment after serving for two years.

The Council of the Institute of Metals, 4 Grosvenor-gardens, London, S.W.1, have awarded the Institute's Platinum Medal for 1956 to PROFESSOR G. L. CHAUDRON, Doct. ès Sc., Membre de l'Academie des Sciences, Professor at the Sorbonne, Paris, and director of the Vitry laboratories of the Centre National de la Recherche Scientifique. The Rosenhain Medal for 1956 has been awarded to DR. D. MCLEAN, principal scientific officer, Metallurgy Division, National Physical Laboratory, Teddington. The W. H. A. Robertson Medal for 1955 and premium of 50 guineas have been awarded to MR. E. J. THACKWELL, of the Northern Aluminium Co. Ltd., Rogerstone, Monmouthshire.

An honorary Doctorate in Engineering was conferred upon DR. HERMANN RAUSSENDORF in Munich on December 8. He is a pioneer in straw-press design and manufacture and among his contributions towards the development of modern farm machinery is the mounted straw press fitted to the Massey-Harris self-propelled combine. He has now retired but still remains a member of the board of the German Massey-Harris-Ferguson Co., at Eschwege.

MR. G. N. PETTY has been appointed Diesel export manager to D. Napier & Son Ltd., the Vale, Acton, London, W.3. COMMANDER G. N. TORRY, R.N.(ret.), has joined the commercial division of the firm and will be responsible to MR. J. B. WAITE, aero-engine sales manager. MR. W. E. HAMPTON has been appointed aviation export manager.

MR. G. A. V. TYSON is handing over his duties as chief test pilot with Saunders-Roe Ltd. to MR. J. S. BOOTH. Mr. Booth has been for some years Mr. Tyson's deputy.

MR. R. HART STILL has been elected to the board of directors of Bakelite Ltd., 12-18 Grosvenor-gardens, London, S.W.1. Other appointments include that of MR. A. LLOYD as production controller, that of MR. R. C. MOUNTFORD as works manager, Ware, and that of MR. C. A. ROBB as general works manager.

Bristol Aero-Engines Ltd. have reorganised their ramjet department. DR. R. R. JAMISON has been appointed head of the department and an assistant chief engineer of the company. His former position as engineer-in-charge of ramjet development is taken over by MR. M. A. NEDHAM, while MR. H. M. GORRELL is appointed chief designer (ramjets). MR. E. S. MIZEN has been appointed ramjet test engineer and MR. R. G. NEAL has been transferred to the ramjet development department.

MR. L. R. HEWITT, for many years general sales manager of the Ingersoll-Rand Co. Ltd., 165 Queen Victoria-street, London, E.C.4, has been elected a director of the company.

MR. W. D. C. HUSKISSON has accepted an appointment from the United Nations Technical Assistance Administration to advise the Indian Government on the design and manufacture of moulds for the production of plastics at various Indian plants. The appointment is for 18 months.

MR. F. T. HARTLAND has been elected a director of Ruston-Bucyrus Ltd., Excavator Works, Lincoln. He will continue as secretary and chief accountant of the company.

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COMMERCIAL

The Federation of British Industries, 21 Tothill-street, London, S.W.1, announce the formation of the BRITISH SHIPPERS COUNCIL, comprising 57 member organisations. Its terms of reference are to seek and express the united view of the members on matters of policy affecting the relations of shippers with shipping and air interests and with port authorities and the Government, as they have a bearing on the general shipping activities of exporters and importers. The independent first chairman is SIR LEONARD PATON, C.B.E., M.C., and the secretariat is provided by the Federation of British Industries.

HEAD WRIGHTSON PROCESSES LTD., Teesdale House, 24-26 Baltic-street, London, E.C.1, have had their telephone number changed to CLErkenwell 1299.

As from February 1 the name of the HAMPTON LAUNCH WORKS LTD., Platt's Eyot, Hampton-on-Thames, Middlesex, will be changed to THORNYCROFT (HAMPTON) BOATYARD LTD.

FIELDEN ELECTRONICS LTD., Wythenshawe, Manchester, have opened a Midlands office at 18 Wolverhampton-street, Dudley, Worcestershire. The engineer in charge is MR. F. BERNARD PRICE. (Telephone: Halesowen 1861.)

The name of BRUSH BAGNALL TRACTION LTD. is to be changed to BRUSH TRACTION LTD. MR. W. A. SMYTH and MR. E. W. MARTEN, directors of W. G. Bagnall Ltd., retire from the board of Brush Traction Ltd., and MR. J. CALDERWOOD retires from the board of W. G. Bagnall Ltd.

ACROW (ENGINEERS) LTD. have registered a new company, to be called ACROW ENGINEERS (EXPORT) LTD., to take over the export side of their business. MR. H. C. STEBBENS and MR. F. C. DUBOIS are on the board of the new company.

AIR CONTROL INSTALLATIONS LTD., Ruislip, Middlesex, have opened a new branch office in London at 17 Manchester-street, W.1. (Telephone: WELbeck 1306.)

THE NORTHERN ALUMINIUM CO. LTD., Bush House, Aldwych, London, W.C.2, have opened a new sales office at 16 Cumberland-place, Southampton, Hampshire (Telephone: Southampton 25425) and are to open another at 57 Bute-street, Luton, Bedfordshire (Telephone: Luton 7364-5) on January 16. The firm's Manchester area sales office has now been moved to larger premises at 23 Princess-street, Manchester, 2 (Telephone: Central 9335).

MODERN MACHINE TOOLS LTD., Broadgate House, Coventry, have been appointed agents for the Coventry area by the STARTRITE ENGINEERING CO. LTD., Gads Hill, Gillingham, Kent.

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CONTRACTS

Aircraft. The British European Airways Corporation, which has been operating two Heron (Series 1) aircraft supplied by the DE HAVILLAND AIRCRAFT CO. LTD., Hatfield, Hertfordshire, on their passenger and ambulance services in the Western Isles since March, 1955, have ordered a third aircraft for similar duties. The new Heron, like those already in service, is equipped for normal operations carrying 14 passengers, with provision for the speedy installation of two stretchers when necessary. The aircraft is powered by four de Havilland Gipsy Queen 30 Mk. 2 engines, each of 250 b.h.p., driving the firm's two-bladed constant-speed propellers.

Water-Turbine-Driven Alternator. A repeat order for a water-turbine-driven alternator has been placed by the Aluminium Co. of Canada with the ENGLISH ELECTRIC CO. LTD., Marconi House, Strand, London, W.C.2. The alternator is for the Aluminium Company's underground power station at Kemano, British Columbia. The rating of the alternator is 132,000 kVA and the value of the order is 856,000 dols. The placing of the order follows the successful operation of a similar alternator built at the English Electric Stafford Works and delivered to Kemano two years ago.

Walking Dragline Excavator. Another order for a RAPIER W1400 walking dragline excavator has been received by RANSOMES AND RAPIER LTD., Waterside Works, Ipswich, from Stewarts and Lloyds Ltd. This repeat order follows four years of working experience with the original W1400 machine, which strips overburden up to 100 ft. deep from the ironstone beds at Corby, Northamptonshire. The excavator weighs 1,650 tons, carries a 20 cub. yd. dragline bucket on a 282 ft. long boom and is powered by two 1,500 h.p. motor-generator sets running on 6,000 volts supply. The new machine will also be used for stripping overburden at Corby. It will be the third of its size to be built by the firm, the second one being at present in course of erection to the order of the United Steel Companies Ltd., at the ironstone mines at Exton Park, Rutland.

Transmission-Line Cable. The Sudan Light and Power Co. Ltd. have placed an order with BRITISH INSULATED CALLENDER'S CABLES LTD., for approximately seven miles of 33 kV aluminium-sheathed impregnated pressure cable for a new transmission line from Burri power station, Khartoum, to Omdurman. It is anticipated that installation work, which is to be carried out by the Sudan Light and Power Co., with the assistance of the British Insulated Callender's Construction Co., Ltd., will commence in the spring or early summer of 1956. The route will include a crossing of the White Nile.

Ventilating Equipment. A contract valued at £80,000 has been successfully completed for the Australian Aluminium Production Commission by HILLS (WEST BROMWICH) LTD., Albion-road, West Bromwich, Staffordshire. The contract was for supplying a complete natural-ventilation system for the aluminium producing plant at Bell Bay, Tasmania. The equipment supplied included the firm's patent opening roof ventilating shutters and adjustable louvred wall-type air-inlet ventilators.

Transformers. A contract valued at over 2,000,000 dols. has been awarded to FERRANTI LTD., Hollinwood, Lancashire, by the United States Government. It is for 21 single-phase transformers, 18 of which operate at 230,000 volts and three at 115,000 volts. They are for the Dalles dam hydro-electric works on the River Columbia, which divides the States of Washington and Oregon in the Western United States.

Ships. Orders for five motorships of a total value of some £3½ million have been placed by the shipping subsidiary company of the Bowater Paper Corporation Ltd. Each vessel will have a deadweight capacity of 4,750 tons and their hulls will be specially strengthened for navigation in ice. Two of the ships will be built by WILLIAM DENNY & BROTHERS LTD., Dumbarton, one by CAMMELL LAIRD & CO. LTD., Birkenhead and two by the CALEDON SHIPBUILDING AND ENGINEERING CO. LTD., Dundee.

ook Reviews

APPRENTICES IN GERMANY

ining Skill. A report of an investigation into he training of industrial apprentices in Western Germany. *Birmingham Productivity Association*, 95 *New-street, Birmingham*, 2. (7s. 6d.)

The Birmingham Productivity Association is to be congratulated on undertaking this inquiry which was carried out by a team consisting of representatives of management, trade unions and education. The resulting report, written with commendable clarity and brevity, gives a revealing picture of the methods of industrial training of our most serious international competitors.

It is not surprising that the methodical Germans should have developed an elaborate, nation-wide system of apprentice selection, training and certification with legal sanctions behind the apprentice contract; but the extent to which this is controlled by such self-governing, even if sometimes compulsory, bodies as the Chambers of Industry and Commerce and the Chambers of Crafts, will come as a surprise to some readers. This is because it is not realised how strongly the traditions of the old Guilds, with their rigid rules of membership and status distinctions between apprentices, journeymen and masters, have continued to live in modern Germany. What is even more surprising is the flexibility which the Germans have shown in adapting their traditional institutions to the requirements of the new industrial techniques.

Training for industrial and commercial trades is divided between skilled workers (including commercial apprentices and chemical and physics apprentices), who undergo a three to three-and-a-half years training, and semi-skilled workers who serve a learnership of one and a half to two years. Handicraft training (which includes some types of work similar to that performed by skilled craftsmen in industry) must be carried out under the charge of a master craftsman holding a Master's Patent; in 1952 there were 830,000 small establishments, comprising 151 crafts, in which this system operated. In the same year there were 1,034 industrial firms having special apprentice shops. Selection takes place with the aid of a vocational guidance service provided by the Federal Labour Office, and the apprenticeship contract does not become binding until the end of a three months probationary period. There is no age limit for entry. Over a number of years a very complete list of trade specifications and examination requirements has been built up which is to-day administered by the Central Office for Industrial and Vocational Training, and this agency is responsible for keeping the list up to date.

The industrial apprenticeship contract is registered with the local Chamber of Commerce and Industry, which has the right to bring an action against a firm, on behalf of the apprentice, if he has not been given the training laid down in the appropriate trade specification. The problem of the smaller firms is being met by communal training workshops. Apprentices must be under the supervision of a qualified instructor: in industry, an apprentice tutor who has had a technical college (*Fachschule*) education. Apprentices are not paid a wage during training, but a monthly allowance ranging from £5 during the first year to £9 during the fourth. The trade unions play their full part in determining the conditions of apprentice training and are anxious to promote the education and training of their members.

Part-time day education is compulsory throughout the Federal Republic for three years or the duration of the apprenticeship, whichever is the longer. Most of this takes place in vocational schools (*Berufsschulen*) which developed out of the non-vocational day continuation schools. Higher skills may be acquired at technical schools (*Fachschulen*). Technicians are also recruited from these and from the technical colleges (*Höhere Fachschulen*) and management personnel from the technical high schools of university rank (*Technische Hochschulen*). In 1954 there were 1,200,000 boys and girls in the age group 15 to 18, excluding those who proceed to higher education, undergoing systematic training out of a total of 1,900,000. This can be compared with 900,000 in this country between the ages of 15 and 20 attending part-time day or evening classes.

At the end of his apprenticeship an apprentice is required to pass practical, written and oral tests, carried out by the Chambers of Industry and Commerce and of Handicrafts. The practical test pieces and the written papers are common throughout the country, and so are the marking standards. The title of skilled worker accorded to those who qualify bestows a higher status than that of semi-skilled or unskilled worker and enables the holder to qualify for a Foreman's Certificate or a Master's Patent at the age of 24 or over.

There is a clear relationship between the enthusiasm for, and importance attached to, apprentice training in Germany and the status which it confers. In fact the team which wrote this report were impressed by the well defined social strata based on education and training into which industrial personnel divided itself, so that the system appears to be restricted to preparing boys for those positions in society which their parents can secure for them and the chances of an apprentice reaching a grade higher than foreman are rare. This is typical of the Continental system as a whole and fits the general pattern of German social life. The team were not convinced that, although the system had served the country well, especially during the present period of rehabilitation and termendous expansion, the limited promotion prospects would continue to be a permanent feature of the German social structure in industry. There is obviously here a conflict, which can be seen in reverse in our own arrangements, between the need under modern conditions for jobs to be filled by those with adequate specialised education and training, and the social need to keep free the ladder of advancement for every able worker. The solution for us can only lie in a thoroughly democratic system of basic education, and the strengthening of our traditional provision of educational " ladders " and " bridges " for those who proceed straight from school into industrial training. It would be interesting to see what the effect on German industry would be of developing such arrangements within their present very thorough training system.

TO BUILD A DAM

Davis Dam and Power Plant: Technical Record of Design and Construction. *Superintendent of Documents, U.S. Government Printing Office, Washington, 25, D.C., U.S.A., and the Bureau of Reclamation, Denver Federal Center, Denver, Colorado, U.S.A.* (3.25 dols.)

The Colorado River, which is some 2,000 miles long, is formed by the junction of the Green River, which rises in the State of Wyoming, and the Upper Colorado, which rises in the State of Colorado. After being joined by a number of tributaries, the river passes through the famous Grand Canyon and other canyons formed in the Colorado Plateau. The upper part of the river flows approximately in a south-westerly direction, but at a point some 1,600 miles from its source changes direction and flows southward, entering the north tip of the Gulf of California; the last 60 miles of the course lie in Mexico. The Hoover Dam, originally known as the Boulder Dam, is situated at the point where the river turns south, and the section below this dam has been the subject of regulation works of one type and another over a period of nearly 50 years.

The Davis Dam is the most recent of these structures (it was completed in 1953) and this voluminous report deals with its design and construction in great detail. The Davis Dam is situated approximately midway between the Hoover Dam and the Parker Dam and its purpose is to provide storage additional to that furnished by Lake Mead, which is formed by the Hoover Dam, and to ensure that the 1,500,000 acre-ft. of water per annum, which by treaty have to be delivered to Mexico, shall be available. The construction of the Davis Dam has resulted in the formation of Lake Mohave, which is 67 miles long and occupies the entire reach of the river between the Davis and Hoover Dams. The normal high water level of the lake is at the tailwater elevation of the Hoover Dam power plant. In addition to river control and water conservation, the Davis Dam provides important further power service and it embodies a station containing five 62,200 h.p. turbine sets.

The Davis Dam is an earth and rockfill structure 1,600 ft. long, with a height of 140 ft. above the river bed. It is approximately 1,400 ft. thick at river level and rests on the existing sand and gravel river fill. A cut-off trench 50 ft. deep and 120 ft. wide was excavated under the dam site and filled with impervious material. Its purpose was to intercept permeable surface beds and to minimise differential settlement of the embankment. The dam, made up of three zones with the centre zone of impervious material, does not essentially differ from many other earth-fill dams which have frequently been described, but the detailed account of the de-watering of the construction area is of special interest.

Geological investigations showed the site to be made up of badly fractured and faulted hard granite gneiss, red clay being present in most of the fractures. Very extensive grouting was undertaken, no less than 367,823 grout holes being driven; they varied in depth from 35 to 360 ft. Prior to the de-watering operation, the river was diverted from the site. This was a major operation in itself. A diversion channel was dug around the site which involved the excavation of 3,838,000 cub. yd. of material. The spillway of the Davis Dam has a capacity of 273,000 cub. ft. per second, but for the actual diversion of the river, the flow was, for two weeks, limited to 25,000 cub. ft. per second by controlling the flow from the Hoover Dam. An upstream cofferdam was constructed with controllable openings and at the time these were closed to divert the river the flow was actually only 11,000 cub. ft. per second.

A downstream cofferdam was also built and the de-watering operations were undertaken between the two structures. Hundreds of sand boils appeared in the isolated area apparently caused by water from the diversion channel flowing under the diversion dyke and cofferdam through a pervious stratum near the surface. Drainage was carried out by means of well points, consisting of $1\frac{1}{2}$ in. diameter pipe risers with a 2 ft. $5\frac{1}{2}$ in. length at the lower end covered with a 48 mesh inner screen and a $\frac{3}{16}$ in. round-hole outer screen. The maximum discharge of the well pumps for the whole area was 27,000 gallons per minute.

This report is not a general treatise on earth-dam design and construction; it is a description of an individual case. None-the-less, it contains much information likely to be useful in other connections. This brief description of the foundation work on the Davis Dam must not be taken to indicate that the report is concerned mainly with that aspect of the work. Concrete construction and the installation of the power plant receive equal attention, and the whole forms a valuable description of a modern hydro-electric installation. The tables covering purchasing costs of material and plant, and cost of their installation in individual detail should prove of value to anyone concerned with work of the type dealt with.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

The Elements of Industrial Radiography. By S. V. RAINEY and H. W. HOGBEN. *Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (3*s.*)

This book discusses the application of X-rays and gamma rays to industry and engineering. It describes the nature and methods of production of both, which should be selected for a particular use, and the safety precautions that should be taken.

Year Book of the Heating and Ventilating Industry, 1955. *Technitrade Journals, Limited,* 8 *Southampton-row, London, W.C.*1. (7*s.* 6*d.*)

The aim of this book is to provide technical, contractual and other trade information for the benefit of architects, consulting engineers, surveyors and others who are frequently in close contact with heating and ventilating contractors. The information includes a heating and ventilating literature index; a selected list of British Standards; rates of wages for craftsmen and apprentices; standard conditions of trading; a buyers' guide; trade names and manufacturers' addresses. In this ninth edition, an additional chapter is devoted to the new Form of Direct Contract prepared by the Federation of Associations of Specialists and Sub-contractors. Technical articles on fuel consumption, farm heating and ventilation, and selection and application of unit heaters are also included.

The Electrical Year Book, 1956. 49th edition. *Emmott and Company, Limited,* 31 *King-street West, Manchester* 3. (3*s.* 6*d.*)

The latest edition of this well-known publication contains a new section in which a concise account is given of electronic fundamentals and methods. It is illustrated by reference to the appropriate applications. The section on lighting now includes matter on the quick-start fluorescent lamp. Much useful information is still included.

Temperature Measurement. By N. T. VAN DER WALT. *Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (3*s.*)

This book begins with definitions of heat and temperature, and then describes various types of thermometer with theoretical explanations and practical details. There are descriptions of mercury in glass, alcohol, distance, and resistance thermometers, and thermocouples and pyrometers.

Prevention of Wet-Weather Damage to Surface Dressings. Road Note No. 14, second edition. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (9*d.*)

Road Note No. 14 describes three simple processes of using adhesive agents to protect bituminous dressings for newly-laid roads and pavements from the action of water. The Note describes each method in detail, and appendices give specifications for solutions used in the proposed treatments and details of a laboratory test for adhesive agents.

Constructional Steelwork. By OSCAR FABER. *E. and F. N. Spon, Limited,* 22 *Henrietta-street, London, W.C.*2. (50*s.*)

Dr. Faber's new book *Constructional Steelwork* is a guide for architects, students and structural-engineering draughtsmen to the "simple" design of steel structures according to the premises of B.S.449-1948. Commencing with a review of elementary statics, the author reviews drawing-office procedure for frequently occurring problems met in the design of single- or multi-storey buildings, making use of a large number of worked examples. Mathematics has been kept to a minimum and no attempt is made to introduce modern or complex design methods, such as either the plastic design of members or moment distribution methods.

Concrete Materials and Practice. By L. J. MURDOCK. Second edition. *Edward Arnold (Publishers), Limited,* 41 *Maddox-street, London, W.*1. (40*s.*)

Dr. Murdock sets out in this book to provide a broad outline of the science of concrete making, particularly the translation of knowledge gained by testing and research into field practice. The properties of concrete are stated early in the book, followed by a discussion of the basic materials and techniques of concrete making under various conditions. The method of testing, the design of mixes to meet various requirements, and the methods of quality control on site described are all said to have given satisfactory results. Much of the book is concerned with contracts carried out by George Wimpey and Company, Limited, but Dr. Murdock has also made considerable use of results of researches made at the Building Research Station and the Road Research Laboratory.

The ISCC-NBS Method of Designating Colors and a Dictionary of Color Names. National Bureau of Standards Circular 553. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (2 dols.)

In 1939 there was published a Method of Designating Colors as a solution of the problem proposed by the first chairman of the Inter-Society Color Council, who said: "A means of designating colors . . . is desired; such designation to be sufficiently standardised as to be acceptable and usable by science, sufficiently broad to be appreciated and used by science, art and industry, and sufficiently commonplace to be understood, at least in a general way, by the whole public." This method was developed with the assistance of the American Pharmaceutical Association following plans outlined in 1933 by the Inter-Society Color Council. As result of suggestions from members of the ISCC, a revision of the proposed system was made and recommended for use in general colour description. The revised colour designations are defined in Munsell terms by 31 name charts, one for each of 31 ranges of Munsell hue. The ISCC-NBS equivalents of 7,500 colour names previously defined by reference to 11 different sets of material standards have been determined and listed both alphabetically and by ISCC-NBS colour designation to form a dictionary of colour names.

Titanium in Iron and Steel. By GEORGE F. COMSTOCK. Published for the Engineering Foundation by *John Wiley and Sons, Incorporated,* 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (6 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (48*s.*)

The author, who is consultant and was formerly assistant director of research to the Titanium Alloy Manufacturing Division of the National Lead Company of the United States, has reviewed some 300 technical papers and articles dealing with the subject of titanium in iron and steel. The book opens with a general discussion on titanium and its ores, and their concentration and preparation. The author then goes on to examine the properties and effects of the element as an addition to cast iron and steel, and discusses such matters as deoxidising effects, carbide stabilisation and titanium in precipitation-hardening steels.

Konstruktionen aus dem Dampfturbinenbau : Sammlung von Konstruktionszeichnunben für Technische Hochschulen, höhere Maschinenbauschulen Ingenieure und Techniker. By A. LOSCHGE. Second edition. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.*35. (10.50 D.M.)

This publication is the second edition, consisting of 199 constructional drawings relating to steam turbines. It is intended for technical colleges, higher mechanical engineering schools, engineers and technicians. Axial and radial turbines are included and two pages each are devoted to connection diagrams and a recent development in the design of steam turbines. Constructional information and data are provided for each diagram or illustration and these represent the most important individual parts and complete units of modern construction. To show the rapid and extensive development in this direction, some of the older illustrations from the first edition have also been reproduced.

Veröffentlichungen des Deutschen Stahlbau-Verbandes. Part 7 : Gestalteter Stahl. *Stahlbau-Verlags, G.m.b.H., Ebertplatz* 1, *Cologne, Germany.* (10.50 D.M.)

This seventh issue of publications by the German Steel Construction Union gives the text of lectures delivered at a meeting in November, 1954, on the subject of structural steel. The main trend of the lecturers is to handle the subjects from the point of view of the architect and the constructor so as to promote co-operation between them. Opinions are expressed on individual modern and older structures as well as types in general and this is supplemented by diagrams, illustrations and a certain amount of data. The first address at the meeting is an appraisal of previous lectures on the same lines. The other contributions are: "The character and effect of steel in architectural designs"; "Prestressed steel tube ridge constructions"; "The new hall at Freiburg in Breisgau"; "Trials with concrete-filled tubular supports"; "Planning and execution in industrial construction" and "Architecture and steel windows."

Industrial Law. By J. L. GAYLER. *English Universities Press, Limited,* 102 *Newgate-street, London, E.C.*1. (30*s.*) (Reviewed on page 849, in the issue of December 23.)

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Cutting and Metalworking Oils. C. C. WAKEFIELD & CO., LTD., 46 Grosvenor-street, London, W.1. A book entitled *Cutting and Metalworking Oils* was published by Wakefield's in 1948, but as both machining techniques and cutting oils have developed considerably since then, a new book with the same title has been produced to bring the subject up to date. Starting with a brief historical survey the text proceeds to an appraisal of the fundamentals of metalworking and cutting. The functions of the cutting fluids are then discussed, various machining operations are studied and the appropriate oils are recommended. The handling, application and maintenance of cutting oils are also dealt with, and there are chapters on cold-working lubricants and heat-treatment oils. Eighty-page illustrated book, with an oil-selection chart covering most machining operations and materials.

Electric Heating Installations. UNITY HEATING LTD., Chilworth Manor, Southampton. Thermostats; watertight, flameproof, and gas and watertight tubular heaters; "Floodwarmth" heaters in various types: standard, flashproof, low temperature, and skirting panels; "Floodwarmth" unit heaters and convectors. Folder containing illustrated leaflets with brief specifications and ranges available.

Precision Pulse Oscilloscope. NEWPORT INSTRUMENTS (SCIENTIFIC AND MOBILE) LTD., Newport Pagnell, Buckinghamshire. Precision pulse oscilloscope for quantitative measurement of the characteristic features of pulsed and transient wave forms. Details of construction, including high beam current cathode-ray tube, which gives a bright sharp trace under full daylight conditions. Illustrated leaflet.

Capstan Lathe for Overseas. MURAD DEVELOPMENTS, LTD., Stocklake, Aylesbury, Buckinghamshire. A simplified version of the 1 in. bar capacity Murad capstan lathe, specially designed for newly-industrialised overseas countries, and for instructional purposes in technical colleges. The machine has therefore been made as simple as possible consistent with accuracy and long life. Illustrated leaflet.

Megger Selection Chart. EVERSHED AND VIGNOLES LTD., Acton-lane Works, Chiswick, London, W.4. A guide to the correct choice of the various instruments marketed under the world-renowned "Megger" trade mark. Charts enable a proper selection to be made for a wide range of duties and give references to booklets from which more detailed information can be obtained. Illustrated leaflet.

Coal Cutting and Loading. BRITISH JEFFREY-DIAMOND, LTD., Wakefield. The B.J.D. Anderton shearer-loader for simultaneous cutting and loading of coal from a longwall face to a conveyor. The machine consists of an electrically-driven drum carrying a number of picks on its periphery, and a plough which turns the cut coal on to the conveyor as the machine draws itself along the coal face. Illustrated leaflet.

Ash Handling. INTERNATIONAL COMBUSTION PRODUCTS LTD., 19 Woburn-place, London, W.C.1. Complete plant to handle ash, dust and grits from boiler plants; gravity sluice systems, sluicing either to a swirlpit or to a sump; submerged chain ash conveyor; ash handling by Beaumont skip hoist. Illustrated booklet with perspective sectioned drawing of typical application.

Continuous Channelling System for Fluorescent Lighting. BENJAMIN ELECTRIC LTD., Brantwood-road, Tottenham, London, N.17. Fluorescent lighting system designed to meet the demand for higher levels of illumination. Simple installation. Illustrated folder.

Screenless Hammer Mills. STURTEVANT ENGINEERING CO. LTD., Southern House, Cannon-street, London, E.C.4. Screenless superfine reduction mills for fine dry powders smaller than 300 mesh employing air separators and cyclone collectors. Publication 8301.

Electric Fork Trucks. YALE & TOWNE MANUFACTURING CO., Wednesfield, Wolverhampton. "Worksaver" fork trucks with capacities from 1,500 to 3,000 lb. and single or telescopic lift. Four Duplex telescopic lift models are described in bulletins B1176, 1076, 1107 and 1163.

Sewage Treatment. JONES AND ATTWOOD LTD., Stourbridge, Worcestershire. "Evenflow" sewage distributors for settling tanks 6 ft. to 20 ft. in

iameter suitable for serving up to 100 persons. Brief specification and ordering chart giving details of 29 stock sizes. Illustrated leaflet.

ecial Attachments for B.S.A. Acme-Gridley Machines. B.S.A. TOOLS, LTD., Mackadown-lane, Kitts Green, Birmingham, 33. Attachments for extra operations on B.S.A. Acme-Gridley multi-spindle automatic bar and chucking machines. They include equipment for recessing, picking-up the workpiece, magazine loading, thread cutting, saw slotting, drilling, cross-milling, and oil-grooving. Illustrated brochure.

Vitreosil Industrial Ware. THE THERMAL SYNDICATE LTD., Wallsend, Northumberland. Vitreosil (pure fused quartz and silica) for use in industrial processes, particularly for acid-resisting duties; acid distillation equipment, immersion heaters, insulators, pipes, coolers, basins, crucibles, etc. Illustrated booklet.

Commercial Vans. COMMER CARS LTD., Luton. Specifications of ¾ and 1¼ ton Superpoise vans; 1¼ ton forward control van. Illustrated descriptive leaflets.

Suds Pump. SALESCOPE, 32 Church-street, Lancaster. Gear pumps with relief valves and adjustable gland for handling suds, etc. Four sizes from 120 to 1,250 gall. per minute at 500 r.p.m. Leaflet.

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BRITISH STANDARDS

The following publications have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2 Park-street, London, W.1, at the price given after each title.

Roughness Comparison Specimens. (2*s.* 6*d.*, post free.)

The first of a new series of Standards for roughness comparison specimens, B.S.2634, dealing with specimens of the ground cylindrical type, has been published. In order to afford valid comparisons it is obviously necessary to ensure that there is uniformity between specimens of different makes and that those for a specified grade of steel surface texture and process are similar in appearance. The present Standard deals with specimens exhibiting grades of primary texture ranging from C.L.A. 4 to C.L.A. 63 (as defined in B.S.1134); this range is thought to embrace the values most likely to be required and attained in ordinary cylindrical grinding.

Aluminium and Aluminium-Alloy Ingots and Castings. (10*s.*, post free.)

A first revision of B.S.1490, a British Standard, covering aluminium and aluminium-alloy ingots and castings for general engineering purposes and first issued in 1949, has been prepared and published. It introduces four new alloys while two previously included have been omitted. In addition, some of the alloys have been listed in conditions not previously covered. A number of amendments have also been made to the chemical compositions and mechanical properties of alloys.

Glossary of Terms for Automatic Digital Computers. (3*s.*, post free.)

A new British Standard, B.S.2641, is entitled "Glossary of Terms Relating to Automatic Digital Computers." This has been compiled under the direction of the advisory committee for high-speed calculating machines of the Department of Scientific and Industrial Research, in collaboration with the appropriate committee of the Institution.

The computer terms and definitions contained in the glossary are intended to represent existing general usage in this country, in so far as this has been ascertainable by reference to those working on the subject. The glossary contains about 100 entries, covering fundamental terms, coding systems, storage techniques (mainly electronic), "programming" and routines. For completeness, a few definitions relating to number representation and number scales are included.

Rubber Joint Rings. (2*s.*, post free.)

Another new specification, B.S.2494, is concerned with natural-rubber joint rings for gas mains, water mains and sewers. It supersedes B.S.674 covering rubber joint rings for water mains and sewers, and B.S.772 dealing with rubber joint rings for gas mains. The standard specifies six hardnesses of vulcanised natural rubber joint rings for use in mains containing such fluids as: town gas, coal gas, water gas, natural gas, water and sewage. Details of the material from which the rings are to be made are laid down, together with requirements for physical properties both before and after ageing. Limits are specified for swelling and water absorption and sampling and marking requirements are given.

The Engineering Outlook—1

BRITAIN'S PLACE IN WORLD ENGINEERING

(1) OUTPUT AND MARKETS

Judged by any standard, 1955 was a notable year for the engineering industry. There were important developments in the application of technology to industry, the outstanding example of which was perhaps the rapid orientation of the engineering industry to meet the requirements of the developing nuclear era.

In the economic field it was a year of mixed achievement and frustration. When the Chancellor of the Exchequer announced last April that the engineering industry would be encouraged to increase further its exports while sustaining a major expansion for its products in the home market we marked the occasion with a warning. In a leading article dated April 8 we said, "It will take a major effort on the part of managements, the best use of available technical manpower and an enlightened trade policy on the industry's wage structure to achieve the targets set for the industry in the Economic Survey." Barely three months had passed before the Government issued a warning that the capital development programme had gone beyond the capacity of the metal and engineering industries. On July 26, the Chancellor warned that the nationalised industries, local authorities and public corporations were being asked to prune their development projects.

FANTASTIC DEMANDS

The demands made on the engineering industry in 1955, were in fact fantastic, even when allowance is made for the fact that many of the long-term plans were expected to stretch over a number of years. The Government were rightly concerned to foster the expansionist climate for industry which Mr. Butler had successfully created in 1954. The hot-house conditions which were imposed on the industry in 1955 can be appreciated by listing briefly only the main expansion plans. On to an engineering industry already coping successfully with an increased export drive, mounting orders for machine tools and a major expansion in the fuel and power industries involving the expenditure of little short of £1,000 million within a few years, there came news of a further expansion in the capacity of the iron and steel industry, a new programme of road construction, the extensive development and modernisation of the railway system, a record amount of plans approved for factory buildings to start in 1955 and, in addition to the heavy demands already existing for various capital schemes of social welfare, there was the ambitious school building programme.

At the time of the Economic Survey and the April Budget, the industry was expected to carry the first instalment of this additional load with a modest increase in its labour force. It goes without saying that all this planning for increased output with a small increase in resources was expected to be accompanied by a further effort to increase exports.

Over the year as a whole the rate at which capital goods were produced seems, in fact, to have been notably quicker than in 1954. In 1954, gross capital formation increased by 5 per cent. at constant prices to £1,756 million. In 1955, it went up to £1,941 million, or by 10 per cent., the percentage increase thereby doubling on the year. This 1955 figure is only a provisional estimate put out by a group of Cambridge economists, but it more than hints at the pressure which was building up during the year.

There was a good deal of irony in the situation which developed in the closing months of the year. The engineering industry made considerable progress towards its new targets. Some of these achievements are listed below and others with their implications for the future will be the subject of separate articles in this series. Owing, however, to the success of the Government's policy in stimulating further prosperity, the determination of the trade unions to go for higher wage rates and the inevitable signs of inflation which became apparent as consumer expenditure increased, the confidence abroad in sterling began to falter. As always, no amount of paper planning and business confidence in the home market could withstand the implications of this traditional bell-wether. The Government decided that spending by the public must be reduced and that only essential capital development plans, especially those which would enable production for export to be increased, were to be encouraged. Bank rate, which had been raised in February as a warning of the calculated risk which the Government was taking to expand production on an economy already at full stretch, was raised again in the summer of last year.

In October came the autumn Budget which re-imposed hire purchase restrictions taken off some time previously and raised purchase tax on a number of goods to discourage excessive spending by the public. The results of this policy have so far been encouraging from the point of view of the economy as a whole but it is not surprising that the change from a mildly inflationary to a mildly deflationary policy between the spring and autumn of the year has left industry, including the engineering industry, in a rather confused state of mind.

UNCERTAIN POLICIES

Confidence throughout the engineering industry has taken on a somewhat piebald appearance. At the close of the year Government spokesmen and professional commentators had produced a conflicting babel of opinion about the future: those behind cried forward, those in front cried back. The fact was that nobody knew. The mild deflationary policy of the autumn Budget was apparently having the right effect up to the end of the year, for the pound was stronger and the country's external trade position was improving. On the other hand, the pressure of costs from the side of wages and the mere fact that the autumn Budget was deflationary caused confidence to falter, a faltering which was encouraged by the continuing pressure from the

TABLE I.—VALUE OF UNITED KINGDOM EXPORTS OF METAL MANUFACTURES. (£ MILLION)

	1954		1955			
	1st half	2nd half	1st quarter	2nd quarter	3rd quarter	Oct.
Iron and steel	69·0	67·9	42·7	34·3	36·8	15·6
Non-ferrous base metals	27·6	28·2	15·9	14·2	20·1	9·0
Manufactures of metals	72·4	73·7	42·1	36·6	41·5	14·4
Machinery other than electrical	213·0	196·8	117·0	105·4	115·5	41·4
Electrical machinery, apparatus and appliances	88·4	81·8	48·1	42·4	48·8	17·6
Railway vehicles	24·2	20·1	11·0	8·9	10·6	3·8
Road vehicles and aircraft	159·4	148·1	86·2	80·8	83·0	30·2
Ships and boats	19·2	31·2	11·7	13·9	11·1	5·3

banks for reduction in overdrafts as the credit squeeze continued.

In this state of indecision the engineering industry presented a mixed picture of boom and mild contraction in the later months of the year. Exports in general continued to do well. The heavy engineering industries continued buoyant; indeed, the shipbuilding industry embarked on the biggest burst of prosperity it has seen for some years. Among light engineering industries, however, experience was more mixed. There was no doubt that the Government's policy was aimed at stopping the expansion of industries making consumer durable goods, such as gas and electrical appliances, and that policy began to meet with success. In transport, experience varied. Motor vehicle output went on to new records of production though exports faltered. The locomotive industry received the first benefits from the new and ambitious modernisation scheme for British Railways, but the aircraft industry was once more plunged into a state of uncertainty by the Government's inability to stabilise its air defence policy and the industry's own inability to develop and deliver aircraft to fit official vacillation. Typical of this state of affairs was the decision to stop production on the Vickers V.1000.

To reduce this complicated picture to a coherent pattern it is necessary to consider a few figures. Some of the more detailed statistics are set out in the accompanying tables but in a year of mild ebb and flow of confidence, such as 1955 certainly was, it is helpful to compare a few overall statistics.

Industrial production for the first ten months of 1955 was 4·7 per cent. higher than in the same period of 1954. In terms of the official index of industrial production, with 1948 as 100, the ten months average last year was 134 compared with 128 in 1954. This average figure, however, masked what may prove to be a most significant trend, namely that the rate of increase was slowing down over the year. Thus, in the first quarter of the year production was 6·1 per cent. above the first three months of 1954, but the rate of increase decelerated until in the third quarter the estimated increase was only 3·3 per cent. Lest it should be thought that the summer holidays unfavourably weighted the figures in favour of this conclusion it should be recorded that in October, when the official index for all industries touched 142 (compared with the previous record level of 141 in March) this was only about 3 per cent. higher than in the corresponding month of 1954.

ENGINEERING LEADS

How does this trend in industry as a whole compare with the experience of the metal and engineering industries? In order to compare the movement of the "all industries" index with the engineering index numbers it is necessary to examine the trend for the first half of the year, since the index for the closing months of the year is not yet available. In the first half of 1955 the "all industries" index increased by just over 6 per cent. for the average month, while the index for metals and engineering went up by almost 13 per cent. This buoyant figure for the engineering industry owes much to the records achieved by motor vehicles, shipbuilding and electrical goods. It has, in fact, been a feature of the year that buoyant industrial production has been sustained by the lead given by engineering.

How has this notable expansion output been achieved? Between June, 1954 and June, 1955 the numbers employed in metal manufacture and all engineering industries increased by 5 per cent. Nearly 3½ per cent. of this increase, however, was accounted for between June and December and only 1½ per cent. in the first half of 1955. This picture fits in very roughly with the estimate made in the Economic Survey in March of last year when it said that something like 4 per cent. had been added to the engineering industries labour force in 1954 and that some of the benefit in terms of increased production would be forthcoming in 1955. By the summer of last year, however, it was beginning to look as though the engineering industry might run short of manpower. A 5 per cent. increase in labour over the year to June, 1955, had brought about a 12 per cent. increase in output. The sustained high rate of increase in the engineering industry since last June could only have been brought about by a combination of a continued increase in productivity on the scale which had taken place in the previous 12 months with further increase in its labour force. In the event both have taken place. Between July and September, the numbers employed in the industry have gone up by 1·4 per cent., and productivity has also increased.

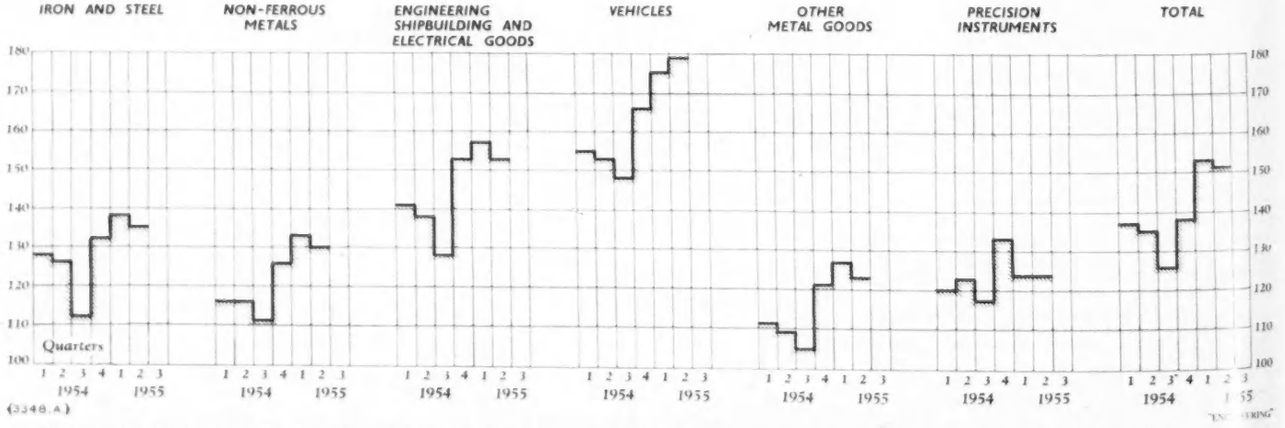
TABLE 2.—EXPORTS OF PRODUCTS OF THE UNITED KINGDOM ENGINEERING INDUSTRY TO SELECTED AREAS (MONTHLY AVERAGE £1,000)

—	1954					1955 (January to September)				
	Machinery other than electrical	Electric machinery, apparatus and appliances	Railway vehicles	Road vehicles and aircraft	Ships and boats	Machinery other than electrical	Electrical machinery, apparatus and appliances	Railway vehicles	Road vehicles and aircraft	Ships and boats
U.S.A.	1,254	225	—	1,609	5	1,221	419	5	1,638	12
Canada	1,558	688	177	817	78	1,507	668	115	1,271	205
Dollar Latin America	981	361	33	511	461	1,089	385	15	636	22
Non-Dollar Latin America*	763	291	124	420	37	866	310	134	360	16
Sterling members of the Commonwealth and Dependencies	11,873	5,863	1,949	9,119	379	12,314	6,387	1,458	10,249	829
Australia	3,930	1,457	426	3,969	158	3,883	1,744	247	4,464	530
Union of South Africa	2,406	1,499	764	1,281	173	2,768	1,463	426	1,790	213
Colonies	2,868	1,703	656	3,035	188	3,146	2,064	1,014	3,667	43
Non-sterling O.E.E.C. countries	8,822	2,625	213	6,294	1,774	10,016	2,740	151	5,491	2,120
O.E.E.C. Possessions	593	117	64	492	8	703	124	28	534	—
Eire and Iceland	1,115	294	84	916	93	1,187	334	136	906	23
Soviet Eastern Europe	233	273	10	20	0	563	327	5	34	—
Summary										
Total Dollar Area	3,891	1,281	210	2,963	1,642	3,957	1,487	136	3,597	827
Total Sterling Area	17,014	8,505	2,702	13,934	715	17,768	9,398	2,622	15,705	1,001
Total O.E.E.C. countries	9,415	2,742	277	6,785	1,783	10,725	2,864	179	6,024	2,122
Middle East countries†	1,303	503	62	790	Nil	1,726	614	72	1,234	—
Soviet E. Europe	233	273	10	20	0	563	327	5	34	—
Rest of World (residual)	2,290	875	435	1,133	57	2,821	793	372	1,197	121
	34,146	14,179	3,696	25,625	4,197	37,560	15,483	3,386	27,791	4,071

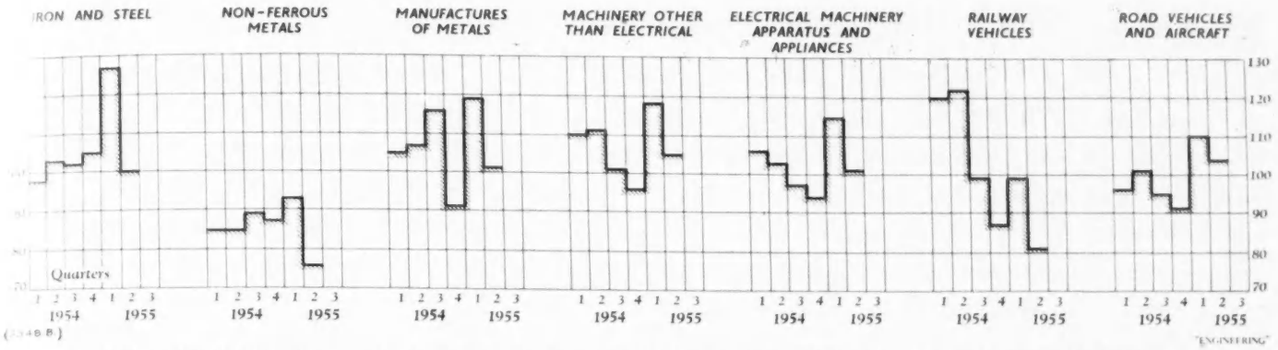
* Peru, Chile, Brazil, Uruguay, Argentine Republic and Paraguay. All other South and Central America classified under Dollar Latin America.
† Israel, Jordan, Egypt, Libya, Saudi Arabia, Iraq, Iran, Lebanon, Syria.

EXPORTS

In the first nine months of 1955, total exports from the United Kingdom increased by 6 per cent. in volume and 6 per cent. in value. In other words prices were comparatively stable. Exports of engineering goods probably did rather better than this, and even during the six months April to October, 1955, which covered the period of the rail and dock strike, engineering exports went up by 7 per cent. in value and by 5½ per cent. in volume. Thus engineering exports went abroad in larger quantities and at slightly higher prices than in the corresponding period of 1954—a trend which probably continued into the last quarter of the year. Like all exports, engineering goods suffered from the hold-up at the docks during the summer and from the railway strike. Thus, in the main categories of engineering exports, only that covering road vehicles and aircraft was higher measured by value in the second quarter of 1955 compared with the second quarter of the previous year. Between these two periods, exports of electrical machinery were down by 2·8 per cent. and exports of machinery other than electrical fell by as much as 5·2 per cent. There was fortunately a big recovery in shipments in the third and fourth quarters of the year and, as Table 2 shows, the value of exports between January and September, 1955, was higher than in the corres-



Index of production in various branches of the United Kingdom engineering industry for the whole of 1954 and the first half of 1955 (1948 = 100)



Volume of United Kingdom exports of various engineering categories for the whole of 1954 and the first half of 1955 (1950 = 100).

ponding period of 1954 for electrical machinery, machinery other than electrical and for vehicles and aircraft. Exports of ships were lower, reflecting the reduced activity in the shipbuilding yards in the earlier part of 1954, and railway rolling stock was also down.

Although prices were higher for engineering exports in 1955 than in 1954, there was a further intensification of competition in overseas markets. An investigation on behalf of the Treasury undertaken at the end of 1954, showed that German exports were expanding more rapidly than those from this country. At that time Germany was exporting as much non-electrical machinery as the United Kingdom, and within this group their progress in metal-working machine tools was outstanding. (On the other hand, British tractors were going abroad in much larger quantities than those from Germany.) In electrical machinery this country's lead was still appreciable. This trend has broadly continued through 1955, but in other sectors competition has seriously intensified. The challenge of the German motor-vehicle industry has increased in foreign markets, and the day has been brought nearer when competition from the aircraft industry on the Continent will have to be considered more seriously. France is an important contender here in the near future and eventually German competition will reassert itself.

WESTERN EUROPE

Despite the growing competition from Germany (which up to a point must be considered inevitable since Germany was for a number of years excluded for political reasons from its traditional markets) 1955 was notable for signs of an increasing interest by British manufacturers in Western European markets. There was throughout the year a certain amount of official propaganda to persuade the engineering industry, among others, that the new expansionist philosophy in Western Europe and the success in the further liberalisation of import trade under the auspices of the Organisation for European Economic Co-operation would provide British industry with increased export opportunities. Traditionally, ran the argument, this country's manufactured goods had sold mainly to primary producing countries but there were reasons for thinking that the expansion and modernisation of industry in Western Europe (and perhaps also in Eastern Europe?) would provide more business in the short run than the primary producers. The Copenhagen Fair was organised during the year under the joint royal patronage of Denmark and the United Kingdom in an effort to stimulate further this country's export drive in Scandinavia. Exporters were exhorted not to assume that Germany's traditional markets in Western and Central Europe could not be invaded. The evidence is in fact quite impressive that for some time to come the British manufacturer may be able to expand his sales to Western Europe more rapidly than elsewhere.

Point was suddenly given to this argument in October when the Australian Government announced its long-awaited import cuts. At one blow these cuts severely reduced this country's largest single market for engineering products. Fortunately the decline in export opportunities to Australia coincided with the development of boom conditions in North America. In the autumn, exports to the United States reached a record level. Table 2 shows that even in the period January to September, which had the disadvantage of the summer strikes without the full benefit of the autumn recovery in shipments, exports of main categories of engineering goods to the dollar area were on the whole noticeably higher than in the same period of 1954. There is little doubt that this upsurge of activity in North America (which must carry with it prosperity for many other areas throughout the world) has saved this country from the dire effects of serious cuts in exports to Australia. It is worth recalling that it was a swing in the other direction in 1952, when Australia was booming and the United States was in a recession, which saved British exports from serious curtailment. The fact is that British prosperity at the close of 1955 owed a great deal to this fortunate conjuncture of boom off-setting slump in two key markets. The engineering industry has been protected from a severe setback and the whole of the British economy in the closing months of the year was dependent to a notable extent on the prosperity of the engineering industry and therefore on the prosperity of exports from that industry.

From Table 2 it can be seen that there was a useful expansion in trade during 1955 (only nine months figures being available at the time of going to press) between this country and the members of O.E.E.C., and also with Eastern Europe. Exports of non-electrical machinery to members of the O.E.E.C. were particularly satisfactory; exports of vehicles less so, to judge from the table, but they will be higher for the full year 1955 than in 1954. In the case of trade with the Soviet bloc, an improvement was noticeable but the absolute figures are still comparatively small. Trade with the Middle East increased in most categories and this may have been stimulated to some extent by the successful Baghdad Fair at the close of 1954. There was also an expansion in the trade of engineering products to the Colonies and Dominions.

ACHIEVEMENTS IN 1955

There has been a number of notable achievements during the year in individual contracts. Outstanding among these have been the success of the British Steel Mission to India, the consultancy contract gained by Associated Electrical Industries, Limited, to help establish an electrical engineering industry in India, the success of Sir Alexander Gibb and Partners in becoming consultants for the Aswan High Dam in Egypt and the continued success of the English Electric Company in under-bidding the Americans in their home market for electric power equipment.

When all the prizes have been handed out for a year's hard work the fact remains that certain features of the export situation are not satisfactory. There is evidence that this country is getting an ever smaller share of an expanding world market and that it is even losing ground to foreign competitors within the sterling area. It will be a never-ending and probably fruitless controversy as to how far this is due to lack of intensified selling abroad and how far to an inflationary situation at home which encourages the manufacturers to sell on the home market rather than export their goods. Certain it is that the export drive, which is already absorbing the energies of a large section of the engineering industry, will have to be pressed further.

Prospects are not unfavourable. The boom in the United States is expected to carry on into 1956; the outlook in Europe is good, for investment is planned to run at a higher level in most Western European countries, and so long as the American boom lasts there are good prospects that Western Europe will be able to sell in North America and so avoid balance-of-payments crises. Despite the deterioration in political relations between the Soviet bloc and the West there is no indication that the Russians are going to change their trade policy, which in the last two years has been gradually liberalised so far as the West is concerned. Evidence is, of course, still strong that the Russians are encouraging imports from the West of engineering goods to obtain prototypes for copying.

RUSSIAN ECONOMIC PRESSURE

The biggest single factor affecting export prospects at the end of 1955 was probably the signs of Russian economic pressure on the Middle East and India. The emergence of large financial surpluses in the Middle East oil countries and the determination of the Russians to fish in politically troubled waters is likely to speed up the rate of development there, which probably means more potential business but more serious competition. India's potential as a market is still enormous and the Russians are active in that quarter as well. Australia remains something of an enigma. At present it is trying to preserve a large investment programme with a cut in imports. This will be exceedingly difficult to do unless world wool prices recover, so increasing Australia's export income. This might well happen in 1956, for the American boom and continued prosperity throughout the world could raise the demand for wool, which is not burdened with a serious stock position at present although competition from synthetic fibres is an important factor. Until there are signs of such an improvement in wool prices, however, the outlook for British exports in Australia remains problematical.

In the past year, therefore, the engineering industry showed that it could continue to expand its exports against world competition and that it could raise production by higher productivity and by attracting more labour (this last despite full employment and inflation). The export position, however, leaves no room for complacency. At the close of 1955, this country was outstandingly dependent for its prosperity on engineering exports and this situation continues into 1956. Prices and costs may therefore be a critical issue. It is to the importance of raw materials, supplies and costs, and then to labour costs, which we turn in the next two articles in this series.

CAVITATION IN HYDRODYNAMICS

INTERNATIONAL SYMPOSIUM AT N.P.L.

By E. I. Brimelow, M.ENG., A.I.M., ASSOC.I.MECH.E.*

The phenomenon of cavitation was recognised as long ago as 1895 by R. E. Froude, and the trend in ship propeller design over the years has been very much influenced by the need to prevent cavitation if efficient propulsion is to be achieved. The subject is not, however, only of interest to naval architects, but is also the concern of research workers in many fields of engineering. Similar problems arise in the design of hydraulic machinery such as water turbines and pumps, the cooling systems of Diesel engines, lubrication systems and even domestic plumbing. It has also been recognised that cavitation is not only a state of affairs to be avoided, but that normal cavitating systems can be used to good purpose, as in certain branches of chemical engineering, if its mechanism can be sufficiently well controlled.

It was with the object of bringing together the available knowledge on this subject, of focusing attention on the more recent results of research work and of determining the direction of future work on cavitation, that the Ship Division of the National Physical Laboratory organised the Symposium held from September 14 to 17, and attended by about 130 delegates, representing the United Kingdom and 14 overseas countries. The Symposium was officially opened by Sir Edward Bullard, Director of the National Physical Laboratory; and the chairman of the opening session, Dr. J. F. Allan, Superintendent of the N.P.L. Ship Division, introduced Mr. P. Eisenberg,[1] of the United States Office of Naval Research, who, in a stimulating address, made a critical review of recent progress in cavitation research, in which he identified the physical problems still awaiting solution. There followed five half-day sessions, devoted respectively to factors governing cavitation inception, experimental techniques, scale-effect factors, effects on hydrodynamic performance, and cavitation damage. In addition, an informal meeting was arranged during the Symposium to enable those interested in ultrasonic cavitation to discuss their problems. The full Proceedings, including a summary of the discussions, will be published in due course by H.M. Stationery Office.

INCEPTION OF CAVITATION

In his opening address, Mr. Eisenberg pointed out that it was generally accepted that the inception of cavitation (or boiling) in liquids that have not been specially treated was associated with the growth of nuclei, ordinarily sub-microscopic in size, containing undissolved gas, vapour, or both. Although the measurement of air content in cavitation experiments was a standard part of the procedure, little attention had been given to the respective contribution of the entrained, as distinct from the dissolved proportion of the total gas content as normally determined. Then there was the question of cavitation pressure and the possibility of inception at pressures other than vapour pressure in relation to such factors as flow velocity and the number and distribution in size of undissolved gas nuclei.

Mr. E. E. Williams, of the National Physical Laboratory, and Mr. P. McNulty,[2] of the Mechanical Engineering Research Laboratory, summarised the results of investigations made with a small closed-circuit rig, using distilled water, on some fundamental aspects of the inception of cavitation. Measurement of the noise emitted from the cavitation zone was found to be more reliable than a visual method for determining the conditions at which cavitation ceased, in other words the true incipient cavitation conditions.

Using this method the results showed that while the onset of cavitation in flowing water was affected by the amount of air present in the water, the influence of air content was small for true incipient cavitation. There were indications from these results of a velocity scale effect for which, with increasing velocity, cavitation occurred at the higher values of the cavitation parameter, in fact, cavitation was easier to produce. If this was so, it might affect the correlation of results of cavitation testing of models with those of the prototypes, when velocities might be very different. However, Ing. P. Danel, of the Laboratoire Dauphinois d'Hydraulique, Grenoble, commenting on the velocity scale-effect results, suggested that one should not generalise on this basis since the effects of velocity would probably depend on Reynolds number and on the exact shape of the test section, e.g., a larger section might be less sensitive.

EFFECT OF SODIUM NITRITE

Another interesting result was that small additions of sodium nitrite, of the order of 0·3 per cent. by weight, when added to distilled water or laboratory-treated peat-stained natural water, used for this investigation, were found to make cavitation relatively easier. This effect was enhanced with increasing strength of the added sodium nitrite solution. It was suggested, therefore, that the use of a corrosion inhibitor such as sodium nitrite in cavitation water tunnels might give misleading test results. An interesting feature of this contribution was an extract from a high-speed cine-film (4,000 frames per second) taken of developed cavitation, which clearly showed the cyclic nature of the phenomenon and the rebound of collapsing cavities.

Microscopic examination using stroboscopic lighting also revealed small bubbles upstream of the leading edge of the cavitation region, which could be seen entering the cavitation zone at an apparently lower velocity than that of the stream (Fig. 1). These bubbles grew in size in a very thin boundary layer and upon attaining a certain size, formed the cavitation visible to the naked eye. Fig. 2 shows an enlarged photograph of the initial stages of collapse during developed cavitation.

Dr. G. Ziegler[3], of the Technical University, Graz, discussed the results of tests made and determined the pressure leading to cavitation under flow conditions similar to those in hydraulic machinery. He used a test rig having a cross-sectional area of only 20 sq. cm. at the smallest working or test section. With a medium-pressure pump of 60 h.p., cavitation could be produced with a range of velocities in the test section of 6 to 30 metres per second. At the higher pressures the water was enriched with air up to 8 per cent. by volume, using an air-injector. On the other hand, when the installation was running at a low level of pressure, a de-aerator could be used to reduce the air content of the water down to 0·8 per cent. by volume. In the light of modern theories regarding the dynamics of bubble formation, he concluded that his investigations showed that water was able to take on considerable tension under certain working conditions without the inception of cavitation, the tensile stresses depending on the air content and velocity of flow.

Photographic records were made of the influence of these varying conditions on the type of appearance of cavitation. The condition of incipient cavitation was determined optically, acoustically and (to eliminate personal errors) by means of a highly sensitive electrical vibration measuring device. Dr. Ziegler was questioned subsequently during the discussion as to whether he had any preference for one or other of these methods of detection. He replied that, under some conditions, such as at low water speeds and high air content, the optical method was best, and under others the electrical method; however, if one had to be selected, he would prefer to concentrate on improving the electrical method.

Mr. R. H. Spikes, of Joseph Lucas Limited, contributing to the discussion, said that he had found from experience in pumping paraffin at high pressures (1,000 lb. per square inch) through small orifices, that orifice performance was a more reliable guide to cavitation inception than visual or acoustic detection and that he had also found that scale effects on cavitation were practically negligible at high velocities.

DYNAMIC STRESSING

The behaviour of liquids under dynamic stressing was discussed by Professor R. M. Davies and others[5] from the University College of Wales, Aberystwyth. The care necessary to devise a suitable experimental technique for this type of investigation was brought out in this paper, which showed that the earlier estimate of 100 atm. for the tensile strength of water in contact with steel, using a pressure-bar method, had had to be amended in the light of recent experiments, which tended to confirm a previous estimate of 10 atm. obtained with a double-piston method. In the paper reference was made to values of the order of 15 atm. quoted by

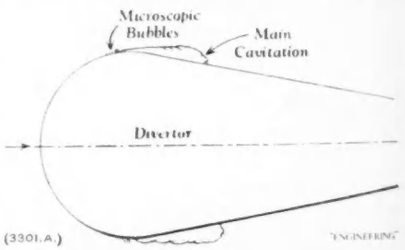


Fig. 1 Diagram of cavitation as viewed microscopically under stroboscopic lighting.

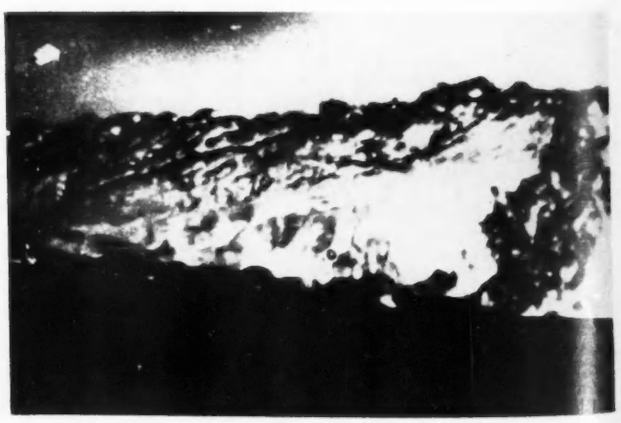


Fig. 2 Initial stages of collapse during developed cavitation (×12, flash exposure 0.00002 sec. duration). Bubbles entering the cavitation zone grew in size in a thin boundary layer and subsequently formed cavitation visible to the naked eye.

* National Physical Laboratory.

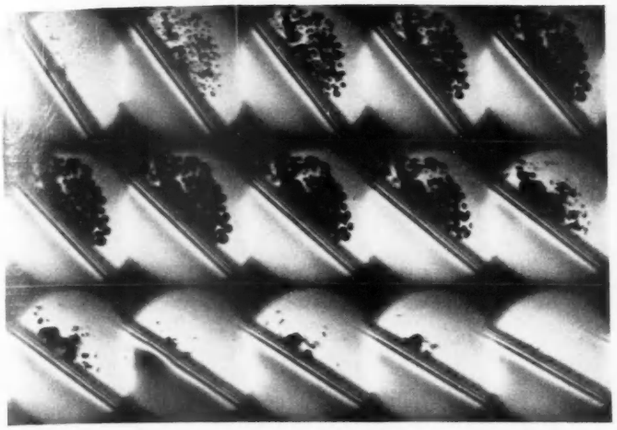


Fig. 3

Fig. 4

Figs. 3 and 4 10,000 cycle acoustic cavitation bubbles in water collapsing on CR-39 photo-elastic plastics (×10, 150,000 frames per second). Fig. 4 shows clearly the propagation of the strain wave in the solid.

other investigators (Temperley and Chambers) for momentary tensions in water near an explosion as measured by piezo-electric gauges and about 20 atm. (Kolsky) based on results obtained under similar conditions. In the ensuing discussion Dr. H. Kolsky, of Imperial Chemical Industries Limited, said that in the underwater work referred to in the paper, two distinct critical tensions for water had been found. The lower one, about 20 atm., corresponded to the " cavitation threshold " at which a cavitated region could first be seen beneath the water surface; and an upper one of about 70 atm. which perhaps could be termed the " ultimate tensile strength " and corresponded to the highest tension the water could maintain for the short period of the stress pulse without breaking up.

ULTRASONIC CAVITATION

Mr. M. Strasberg,[6] from the David Taylor Model Basin, United States, in his paper, discussed cavitation nuclei with special reference to the part they play in the inception of ultrasonic cavitation, that is, cavitation induced by high-intensity sound. For this purpose an acoustical method had been developed for detecting air bubbles as nuclei in water and for measuring their influence on the pressure required for the onset of ultrasonically induced cavitation. Nuclei as small as 6×10^{-4} cm. in concentrations of about 1 per cubic centimetre, and larger nuclei in much smaller concentrations, could be detected. The pressure required for the inception of ultrasonically induced cavitation was measured on the same water in the same spherical flask. When the nuclei were too small to be detected directly by their sound absorption, their size could be estimated from the measured inception pressure. Results were presented for saturated and partially de-aerated tap water. However, it should be noted that the data obtained in these experiments were for undisturbed water.

Professor J. W. Daily and Mr. V. E. Johnson,[4] from the Massachusetts Institute of Technology, were concerned in their paper with the influence of boundary layers and turbulence on the pressure of cavitation inception and the location of inception relative to the solid boundary. In this study special attention was given to the rôle of gas bubbles as nuclei for cavitation and the interrelation of the stability of small gas bubbles, their size and space distribution and the velocity and pressure variations in the turbulent boundary layer. For this work a small water tunnel was used, in which there was essentially two-dimensional flow along the flat boundary wall of a horizontal transparent test section. Conditions were maintained such that they were favourable to the formation of gas bubbles as nuclei for cavitation. During the cavitation process, high-speed motion pictures were taken at various longitudinal positions along the test section. In this way, information could be obtained on the distribution of all bubbles in the boundary layer and of those which expanded rapidly and collapsed with the noise and appearance typical of cavitation. The results indicated that of the bubbles or nuclei observed, the majority were located in the central portion of the boundary layer, with only 1½ per cent. located in that portion of the boundary layer (10 per cent.) nearest the wall; similarly, most of the cavities or expanding bubbles were observed in the central portion of the boundary layer, but none in the 10 per cent. of the boundary layer nearest the wall—a result somewhat unexpected. In the discussion Dr. W. D. Baines, of the National Research Council, Canada, drew attention to the possible intermittent nature of the outer edge of the boundary layer, and suggested that some of the bubbles observed in this investigation might be affected by turbulence. Professor Daily agreed with this, and pointed out that bubbles indeed could migrate to the centre of low-pressure eddying zones within the boundary layer, and this was in fact another way of describing turbulence.

A number of speakers in the discussion commented on cavitation and its effect on efficiency. Mr. E. E. Williams pointed out that cavitation appeared long before it began to affect the performance of propellers in water-tunnel experiments or in pumping paraffin at high pressures through orifices. Dr. Ziegler added that with water turbines, it was the general experience that while efficiency sometimes dropped immediately cavitation began, in other cases there was first an increase in efficiency, followed by a drop when cavitation became more severe. Dip. Ing. J. Osterwalder (Escher Wyss, Switzerland) agreed with Dr. Ziegler and added that efficiency changes, when cavitation occurred in water turbines, depended on running conditions such as specific speed, angle of attack and lift coefficient. Dr. Ing. R. Dziallas, of J. M. Voith, G.m.b.H. Heidenheim, explained that the effect of cavitation depended on its location with respect to the blades, the efficiency falling off more slowly at low angles of attack; there was in fact a point at which it increased.

EXPERIMENTAL TECHNIQUES

Reference has already been made to the importance of experimental technique in research work on cavitation and a special session was devoted to this under the chairmanship of Professor W. P. A. van Lammeren, from the Netherlands Ship Model Basin. A paper by Dr. D. W. Appel[7] of the University of Iowa, on instrumentation for the measurement of fluctuating forces, pressure intensities and velocities; and one by Dr. A. T. Ellis[8] from the California Institute of Technology, on techniques for pressure pulse measurements, and high-speed photography in ultrasonic cavitation, were most useful contributions. As Dr. Appel pointed out, the instrumentation of water tunnels has developed considerably since the use of comparatively simple differential mercury manometers and Bourdon tube gauges only ten years ago; the emphasis now being placed on the development of instruments to measure fluctuations of force, pressure intensity and velocity. He described a water-tunnel balance for the measurement of lift and drag forces, and pitching moment of two-dimensional hydrofoil models in cavitating flow. Its massive structure was considered essential to ensure rigidity and freedom from vibration.

PRESSURE AND VELOCITY MEASURED SIMULTANEOUSLY

A probe was also described, which had been developed to measure separately the velocity and pressure fluctuations in turbulent flow. It was stated that recent developments were directed towards measurement of the local pressure and velocity simultaneously, with a single probe which had a heated platinum film on a portion of the head for sensing the velocity in a manner similar to that of the hot-wire anemometer. A remarkable photographic technique, enabling pictures of cavitation bubble collapse to be taken at the rate of one million per second, and a resolution estimated to be better than 10^{-3} cm. was described by Dr. Ellis in his paper. Using this technique he showed that ultrasonic cavitation bubbles, collapsing on the surface of a photo-elastic solid, set up stress waves in the solid (Figs. 3 and 4).

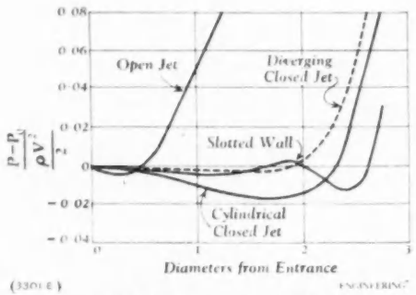
Useful information concerning the instruments designed for the Admiralty Research Laboratory's 30 in. water tunnel and rotating beam channel (ENGINEERING, December 2, page 766, 1955), was given in a paper by Dr. H. Ritter,[9] of the Admiralty Research Laboratory. These were developed in connection with the new Admiralty large-scale testing equipment, which would be used to a large extent for research on cavitation, and included balances for the measurement of force and moment coefficients, and pressure transducers, both using strain gauges as the basic measuring element; details were also given of the ancillary electronic equipment designed for use with these strain gauges.

SMALL TUNNEL

A paper stimulating much discussion was that submitted by Dr. L. G. Straub, Professor J. F. Ripken and Mr. R. Olson,[10] from the University of Minnesota, describing the mechanical design and operational characteristics of a 6 in. recirculating variable-pressure model water tunnel at St. Anthony Falls Hydraulic Laboratory. This equipment was installed for the purpose of providing the prototype design data required in the planning of various types of large cavitation tunnels for the David Taylor Model Basin of the United States Department of the Navy. A ⅛ scale model of a prototype resorber could be included in the circuit, or by-passed if it was so desired.

This paper was a particularly valuable contribution to the Symposium and clearly indicated the usefulness of such a relatively inexpensive small water tunnel where flow and water parameters could be readily varied to provide the design data for large water tunnels. Fig. 5 shows the axial pressure distribution for various types of test section in the 6 in. tunnel.

Commenting on the history and philosophy of resorbers, Professor R. T. Knapp, from the California Institute of Technology, said that the original resorber at CIT had been designed and built in order to overcome some of the difficulties occurring in long period tests under conditions of fully developed cavitation in the working section; it was an attempt to cure the problem of air release without appreciably increasing the



(3301E) ENGINEERING

Fig. 5 Axial-flow pressure distributions for various types of test section in a 6 in. recirculating variable-pressure water tunnel.

power requirements of the tunnel. It was important that the flow through the resorber should be at low velocity, and he felt that a large-diameter continuous tube, with varied elbows, would be better than the layout fitted at CIT which had been largely dictated by restrictions imposed by the building housing the tunnel. An interesting discussion followed on the value of re-absorption devices, with particular reference to propeller water tunnels in view of the considerable cost involved—a question raised by Professor Ripken himself.

RESORBERS

Ing. P. Danel said they had four cavitation test rigs at Grenoble; five years ago one had been fitted with a resorber of the CIT type. This had been so satisfactory that the others were now being fitted with resorbers. He later added that at Grenoble the problem was not whether to fit a resorber, but the best design to adopt. Mr. A. Silverleaf, of the National Physical Laboratory, said that it had been decided to incorporate a large resorber in the new water tunnel about to be built for N.P.L. This was intended for tests on model propellers up to 24 in. diameter and would have a test section of 44 in. diameter. Details of the tunnel and resorber circuits were shown, and in this case a resorber was a necessity because propeller tests at low air contents were considered to be inadequate, and it was essential to be able to carry out experiments with high air contents over a wide range of test conditions, while maintaining clear conditions in the working section.

Professor W. P. A. van Lammeren, who occupied the chair during this session, began the discussion by expressing the opinion that for normal routine work, under fully de-aerated conditions, a resorber was not necessary in propeller water tunnels though they would be desirable for special tests. A resorber was a valuable but expensive device, and he would prefer to spend a fixed sum of money on a larger tunnel without a resorber than on a smaller tunnel which had one.

Dip. Ing. J. Osterwalder contributed by giving a description of tests made in the laboratories of Escher Wyss to determine the characteristics of hydraulic machines, and said that from this experience he considered that test installations without large-size resorbers could fulfil their duties satisfactorily within certain limits in the range of operation. These limits depended on such factors as the design and size of the test plant and the rate at which the water was flowing through it.

M. Danel also commented that in the past, the main interest in the studies of hydraulic machines was incipient cavitation and resorbers were not essential. Now, abnormal conditions such as run-away speeds and fully developed cavitation were important and resorbers were needed for their study.

Professor Dr. H. W. Lerbs, of Schiffban Versuchsanstalt, Hamburg, said that whether or not a resorber would be fitted could not be decided until it was known if the similarity parameters for cavitation depended on total air content or entrained air. He believed that it depended on entrained air, and to maintain this constant in model experiments required either a large tunnel to ensure absorption or a smaller tunnel with a resorber.

SCALE EFFECT FACTORS

A problem of considerable importance to designers of ship propellers and hydraulic machinery is to what extent the results of laboratory-scale investigations on models can be correlated with the actual performance of the full-scale item under service conditions. The fourth session, with Professor J. W. Daily in the chair, was concerned with the scale-effect factors involved and their significance, particularly of the Froude, Reynolds and Weber numbers. Some reflections on scale effects, based on water-turbine cavitation testing, was the subject of a paper by Professor H. Gerber,[11] from the Technical University, Zurich. While no conclusive answer could be given to the question of model size effect, he felt that the existing uncertainty about the usefulness of model testing should not be exaggerated, since a great number of Kaplan turbine plants, some of them in operation for many years, provided evidence for the correctness of the data used in their design and construction. Turbine designers had introduced the absolute head as a parameter in an attempt to eliminate some of the uncertainty involved in scale calculations—a method that had proved quite useful for some low-head runners. For high-head Kaplan runners, the use of a specific peripheral speed had been found advantageous. It was also pointed out that to design and build turbines such as are used in large power stations, for absolute cavitation-free running under all conditions would not be an economical proposition; some cavitation is therefore deliberately tolerated where it does not directly affect strength or efficiency, and when repairs can be made without difficulty using electric welding techniques.

A number of tests are being carried out in propeller water tunnels throughout the world for the International Towing Tank Conference with the object of providing information to enable the results of tests on model propellers to be applied to full-scale ship propellers operating under sea-going conditions. Mr. A. Silverleaf[12] of the National Physical Laboratory, gave some preliminary observations of some experiments, complementary to these tests, on the effect on screw performance of model size and test conditions. Not only did the tests at the N.P.L. show that results with model screws were affected by the type of test section and the size of model relative to the section, but they have suggested that the way the propeller operating conditions were reproduced was significant. It was also stated that other results, not given in detail in the paper, had suggested that cavitation inception points, defined either visually or acoustically, also varied with test conditions as well as with model size.

PROPELLER CAVITATION

Information regarding the propeller cavitation conditions appertaining to destroyers and fast patrol boats during ship trials carried out by the Admiralty, was given by Mr. A. F. Weeks[14] of the Admiralty Experiment Works, Haslar. For this purpose observations and photographic records of propeller cavitation were made through toughened glass viewing-ports provided in the hull surface plating. These ports were arranged so that as many of the parts of the propeller as possible could be viewed, such as the blade tip, face and back, boss, roots of blades, cone and shaft and shaft brackets. Advantage was taken of the stroboscopic effect obtained by synchronising the artificial light flashes with either the shaft or blade frequency. In some cases the cavitation tunnel predictions were confirmed when suitable correcting factors were applied and in other cases cavitation phenomena were demonstrated which were not evident in tunnel tests. For example, face cavitation occurring on a destroyer propeller was not anticipated from model tests while tip vortex cavitation occurred earlier than predicted by tunnel tests when allowance was made for the local wake. The mixed flow past the ship propeller, as compared with the uniform flow conditions of a tunnel, may possibly account for these differences. A number of interesting comments were raised in the discussion on these papers. Professor Lerbs suggested that in attempts to extrapolate two sets of model test results to full-scale effects, the Weber number was important in determining cavitation inception.

HYDROFOILS

Dr. J. D. van Manen, from the Netherlands Ship Model Basin, pointed out that the velocity of water in the tunnel could not be identified with the speed of advance for open water; tests with heavily loaded propellers, such as tug propellers under towing conditions, demonstrated this difference. He felt that an interesting research item was to discover what agreement there was between the beginning of thrust breakdown in the tunnel and on full-scale trials. Commander P. du Cane, of Vosper Limited, described tests to determine the effect of an inclined shaft and various appendages, such as the shaft bracket and rudder, on propeller performance and cavitation phenomena.

A session under the chairmanship of Mr. F. S. Burt, of the Admiralty Research Laboratory, was devoted to the effects of cavitation on the hydrodynamic performance of hydrofoils. Professor M. S. Plessett and Mr. B. R. Parkin,[15] from the California Institute of Technology, reported on two problems which formed part of a study of the forces on hydrofoils. The first was concerned with the effects of shallow submergence on pressure distribution, and the second with an investigation of the forces on hydrofoils in two-dimensional fully cavitating flow. Mr. M. P. Tulin[16], from the United States Office of Naval Research, reviewed certain aspects of supercavitating flow past non-lifting bodies such as two-dimensional struts and axi-symmetric bodies. The important problems of determining their shapes for minimum cavitation drag, and of determining the lift, drag and pitching moment of lifting foils operating at low cavitation numbers, were considered. Emphasis was laid on some recent results which might be particularly useful in the solution of engineering problems.

HIGH STATIC PRESSURES

Professor F. Numachi,[17] from the Tōhoku University, Japan, in a paper he was unable to deliver in person, considered the mode of cavitation occurrence around hydrofoil profiles under high static pressures. This work was undertaken as a sequence to an earlier study of low static head characteristies. The results suggested that, in so far as concerns the point of sharp efficiency deterioration, the cavitation tests on axial-flow turbines and pumps more commonly carried out

Fig. 6 Perspex and aluminium test pieces eroded by cavitation in rotation apparatus.

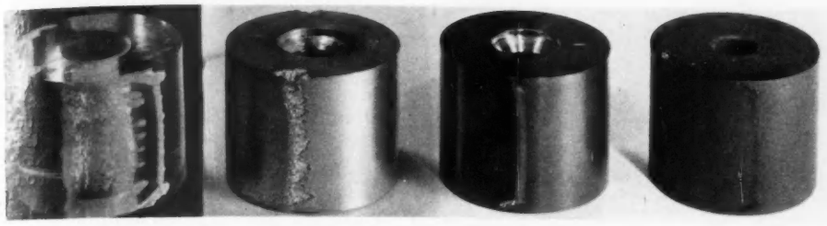


Fig. 7 **Perspex, aluminium, brass and ebonite test pieces eroded by cavitation in flow apparatus.**

comparative to actual head, should not yield data very different from those performed at modified pressures.

CAVITATION DAMAGE

In his opening address, Mr. P. Eisenberg reviewed experimental evidence on the mechanism of cavitation damage which had come to light in recent years, and it was appropriate that he should take the chair at the closing session devoted to this controversial subject. After listening to the papers and discussion it is to be concluded that we are still far from understanding the mechanism of cavitation damage, and perhaps this is not so surprising in view of the present stage of knowledge concerning the cavitation phenomena itself. In previous papers presented at the Symposium evidence had been provided of the mechanical action of collapsing cavitation voids sufficient to set up measurable stresses in the affected materials, and Professor Knapp's[19] paper on the damage potential of fixed-type cavities lent emphasis to mechanical theories. However, as he subsequently remarked in the discussion, it was still difficult to explain why, in a typical test run, there was only one "pit" for over 20,000 cavities which passed round the main zone, which suggested that the position of the cavity at collapse was clearly of importance. He used aluminium specimens to provide a means of recording the blows on the surface arising from the cavitation process; it was observed that the "pits" formed were smooth, round depressions similar to the indentations that could be made by a hard sphere pressed against the surface, with the interesting difference that tool marks were not obliterated but were retained on the deformed surface; and, as far as it could be ascertained, no material had been removed. The low observed pitting rate was at variance with the general concept that cavitation damage was a fatigue-type failure.

EROSION INHIBITED BY AIR

The results of investigations on cavitation erosion in water on test pieces of different form and material were discussed in a paper by Professor R. E. H. Rasmussen,[20] from the Technical University of Denmark. Figs. 6 and 7 show typically eroded test pieces. Special attention was given in this case to the effect of an admission of air bubbles to the water. The experiments were made using a rotation apparatus and a flow apparatus. The materials tested included aluminium alloys of different chemical composition and hardness, cast iron, brass and chemically inert materials such as ebonite and Perspex. In all cases the cavitation erosion could be almost stopped by the addition of air as small bubbles in amounts of the order of 5 to 10 parts per thousand by volume. Even much less air will greatly diminish the erosion. The resistance to damage afforded by the air bubbles was attributed to the buffer effect of non-condensable gas in the cavities.

Dr. W. H. Wheeler[21], of the Mechanical Engineering Research Laboratory, described experiments that had been made to determine to what extent damage produced under cavitation conditions should be attributed to chemical action. The method of investigation was based on the surmise that for any specimen of material a critical level of cavitation severity would exist, related to the tensile and fatigue properties of the material, above which erosive losses would rise sharply. Furthermore, it was expected that this critical severity level would be lowered if ionised liquids were used as compared with pure water or completely non-corrosive liquids. Two possible causes of accelerated corrosion under cavitation were suggested; the first, that stressing of the metal by cavitation collapse impact would alter the local electrode potential of the metal and give rise to electrolytic losses in an ionised solution and, secondly, that air or vapour in the collapsing bubble might be compressed semi-adiabatically to a temperature sufficient to enhance chemical reaction between vapour and metal. For these investigations a magneto-striction vibrator was used and a technique developed to distinguish between metal taken into solution by chemical action and that lost from the surface in particle form. The results appeared to show that much of the actual loss of metal was attributable to the influences of chemical action. A mechanism of cavitation erosion and corrosion based as far as possible on the results obtained was tentatively suggested, and further lines of investigation were indicated.

IMPINGEMENT ATTACK

Mr. G. T. Callis,[18] of the Manganese Bronze & Brass Company Limited, in his paper also reviewed the various explanations of the damage associated with cavitation and drew attention to its similarity with the type of damage caused by severe impingement attack. On this basis a mechanism is suggested for cavitation erosion damage which provides a reasonable explanation of some of the difficulties associated with a purely mechanical-action theory. It is considered that the severe turbulence of a cavitating condition, rather than the collapse of cavitation voids, which is the prime cause of damage, is identical with that of impingement attack. This form of attack is now recognised as a form of electro-chemical corrosion associated with the setting up of small local anodes over the attacked surface. Like cavitation damage it may, in many cases, be prevented by the application of cathodic protection. In the discussion that followed, Mr. D. Rachman, from the Royal Technical College, Glasgow, commenting on Mr. Callis's paper, suggested that electrolytic action could only accelerate the onset of failure, but was not its primary cause; the appearance of some of the failures might be accounted for if the existence of pressure waves were admitted since these might cause high tensile stresses in the fluid on rebound, and, the subsequent "pulling out" of particles of ductile materials. Professor J. Ackeret, from the Technische Hochschule, Zurich, a pioneer in this field, also drew attention to the effects of shock waves in causing damage.

CHEMICAL AND MECHANICAL FACTORS

The papers and discussion at this session were a fitting reminder of the pertinent words of Dr. U. R. Evans on this subject—over twenty years ago—the words with which Mr. Callis concluded his paper—"But as long as the engineer insists on ignoring the chemical side, and the chemist the mechanical side, so long will the complete understanding of these cases (of cavitation erosion) be impossible."

In reviewing the Symposium as a whole, there is no doubt the objectives of its organisers were fully achieved and that research workers and engineers concerned with problems associated with cavitation, not only in hydrodynamics but in wider fields, will be stimulated to still greater activity along lines clearly identified during the Symposium as requiring more attention.

Papers Presented at the Symposium

[1] "A Critical Review of Recent Progress in Cavitation Research," P. Eisenberg (Office of Naval Research, U.S.A.).

[2] "Some Factors Affecting the Inception of Cavitation," E. E. Williams (N.P.L.) and P. McNulty (M.E.R.L.).

[3] "Tensile Stresses in Flowing Water," Dr. G. Ziegler (Technical University, Graz).

[4] "Turbulence and Boundary Layer Effects on Cavitation Inception from Gas Nuclei," Professor J. W. Daily and V. E. Johnson (Massachusetts Institute of Technology).

[5] "The Tensile Strength of Liquids under Dynamic Stressing," Professor R. M. Davies, Dr. D. H. Trevena, N. J. M. Rees and G. M. Lewis (University College of Wales, Aberystwyth).

[6] "Undissolved Air Cavities as Cavitation Nuclei," M. Strasberg (Taylor Model Basin).

[7] "Instrumentation for the Measurement of Fluctuating Forces, Pressure Intensities and Velocities in Studies of Cavitation," Dr. D. W. Appel (University of Iowa).

[8] "Techniques for Pressure Pulse Measurements and High-Speed Photography in Ultrasonic Cavitation," Dr. A. T. Ellis (California Institute of Technology).

[9] "Instrumentation for the ARL Water Tunnel and Rotating Beam Channel," Dr. H. Ritter (Admiralty Research Laboratory).

[10] "The Six-inch Water Tunnel at the St. Anthony Falls Hydraulic Laboratory and its Experimental Use in Cavitation Design Studies," Dr. L. G. Straub, Professor J. F. Ripken, and R. Olson (University of Minnesota).

[11] "Some Reflections on Modern Scale Formulae for Cavitation Phenomena," Professor H. Gerber (Technical University, Zurich).

[12] "Air Entrainment at the Rear of a Steady Cavity," R. N. Cox and W. A. Clayden (Armament Research and Development Establishment, Fort Halstead).

[13] "Preliminary Observations on a Geometrically-Similar Series of Model Screws," A. Silverleaf (N.P.L.).

[14] "Ship Propeller Cavitation Patterns," A. F. Weeks (Admiralty Experiment Works, Haslar).

[15] "Hydrofoils in Noncavitating and Cavitating Flow," Professor M. S. Plessett and B. R. Parkin (California Institute of Technology).

[16] "Supercavitating Flow Past Foils and Struts," M. P. Tulin (Office of Naval Research, U.S.A.).

[17*] "Effect of Static Pressure Differences on the Cavitation Characteristics of Hydrofoil Profiles," Professor F. Numachi (Tōhoku University, Japan).

[18] "A Suggested Mechanism of Erosion Damage," G. T. Callis (Manganese Bronze and Brass Co. Ltd.).

[19] "Further Studies of the Mechanics and Damage Potential of Fixed Type Cavities," Professor R. T. Knapp (California Institute of Technology).

[20] "Some Experiments on Cavitation Erosion in Water Mixed with Air," Professor R. E. H. Rasmussen (Technical University of Denmark).

[21] "Mechanism of Cavitation Erosion," Dr. W. H. Wheeler (M.E.R.L.).

[22*] "Experimental Study of the Intensity of Erosion due to Cavitation," K. K. Shalnev (Academy of Sciences, U.S.S.R.).

* Paper submitted to Symposium but not presented by the author in person.

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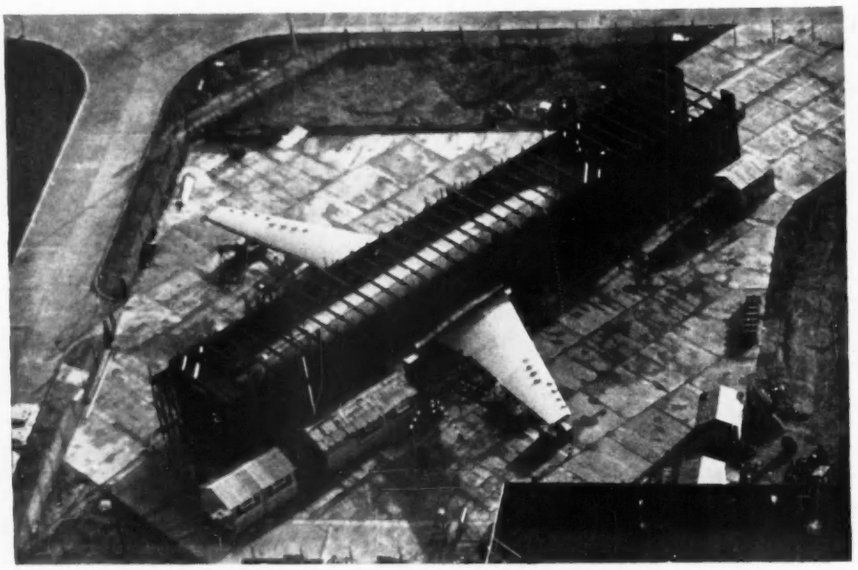
MEASUREMENTS FOR MANAGEMENT

Residential Course

A three-week residential course for senior executives on "Measurements for Management" is to be held at Sundridge Park Management Centre, Bromley, Kent, from February 26 to March 17. The syllabus covers the field of management and its main divisions; the factors which management must measure and control in the organisation; principles of the various forms of measurement; measurements and indices for productivity, sales, profitability, labour and capital costs, inspection and quality, personnel planning; and the installation of effective procedures. The inclusive fee for the course is 110 guineas.



The new 290,000 gallon tank at the de Havilland works at Hatfield is in two sections. In the larger, 220,000 gallon, section is installed a Comet 2 airframe for repeated cabin-pressure and flight-load tests. In the forward smaller section, representative portions of the Comet 4 fuselage will be tested. Later, the dividing bulkhead will be removed for installing the larger Comet 4 fuselage, when this is ready for test.

COMET FUSELAGE FATIGUE TESTS

NEW WATER PRESSURE TANK AT HATFIELD

Repeated cabin-pressure testing with superimposed steady-flight and gust loads has recently commenced on the strengthened Comet 2 airframe in a new tank-test rig at the works of the de Havilland Aircraft Company Limited, Hatfield. The new water tank at Hatfield follows closely the established formula originally devised by the Royal Aircraft Establishment. The complete fuselage is submerged in the tank, and the wings protrude through the sides through flexible water seals which allow for the movement of the wings as the loading is applied.

The tank is 140 feet long, 20 feet wide and 16 feet deep and has a total water capacity of 290,000 gallons. It can accommodate an aircraft up to the size of the Comet 4. The length is sufficient to allow a division to be put into the tank, dividing it into two sections 104 feet and 36 feet long respectively. The longer of the two sections, which has a capacity of 220,000 gallons, at present accommodates a Comet 2, as seen in the accompanying illustration, while the shorter will be used for representative fuselage test sections of the Comet 4. Water for the tank is stored in an adjacent reservoir which holds 330,000 gallons.

The tank is filled from the reservoir by a Worthington-Simpson centrifugal pump and the task can be accomplished in about four hours. Considerable care is necessary during the filling and the emptying process to ensure that the water level in both the tank and the fuselage remains equal: any significant discrepancy in water level would lead to serious damage either by overloading the fuselage or by floating it off its supports. In order to ensure that the water can flow freely into and out of the fuselage during filling and emptying, the luggage loading hatches situated in the belly of the fuselage are opened by remotely-controlled hydraulic jacks.

The loads applied to the aircraft under test are designed to include all the significant elements which contribute to fatigue in the main structural members. The individual loads are as follows:— (1) fuselage pressure ranging from zero to maximum differential (8¼ lb. per square inch); (2) vertical tail gust loads, with simulated inertia loads for the fuselage and the contents of the cabin; (3) vertical wing loads, applied at the front and rear spars, with gust loads superimposed on steady flight loads.

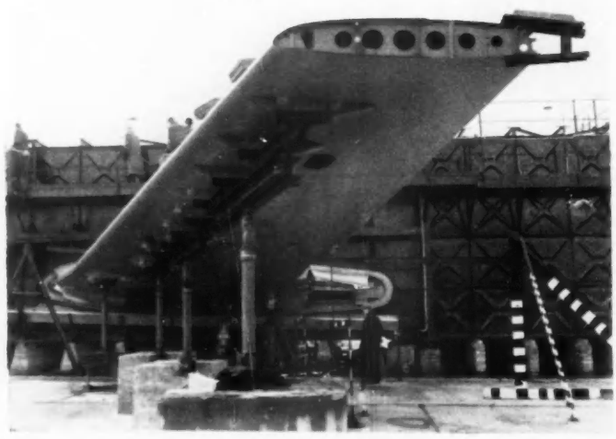
The fuselage pressure loads are applied by means of two Saffran centrifugal water pumps operated by 8½ h.p. electric motors. Normally, one pump is sufficient to raise the pressure to the maximum differential at any rate for the Comet 2, which needs only the addition of about 100 gallons to raise the pressure to 8¼ lb. per square inch.

The wing loads and the vertical fuselage loads are imposed by a system of hydraulic jacks, as illustrated. In the case of the wings, vertical and torsional loads are applied by six hydraulic jacks on each wing. The peak loads applied to the wings amount to 14 tons and represent a 10 ft.-per-second gust. These loads produce a deflection of some 18 in. at the wing tips. Vertical gust loads are applied to the tail by a single hydraulic jack while a system of levers applies inertia loads representing the weight of the fuselage and the passengers and freight. The hydraulic jacks are actuated by three Stein and Atkinson hydraulic pumps driven by individual electric motors each of 15 h.p. Both the water-pressure system and the hydraulic jack circuits are controlled by automatically-regulated hydraulically-operated valves fed from a hydraulic services pump. It is essential that loads greater than those which will in fact be met with during the life of the aircraft should not be applied, because such loading has been found to have a considerable effect on the subsequent fatigue life. For this reason safety devices are introduced into each of the circuits to prevent excess loads being applied by accident.

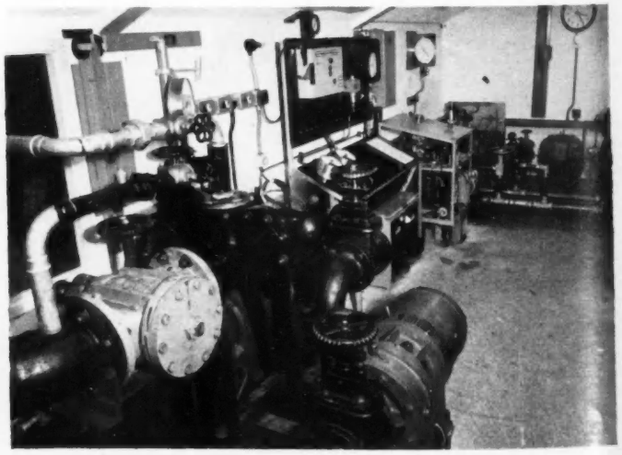
THREE-HOUR FLIGHT SIMULATED IN FOUR MINUTES

The water-tank test is designed to simulate as closely as possible the loads which would be met with during representative flying. In the case of the Comet 2 a flight is considered to last three hours, during which period it is estimated that the cumulative effect of the gusts encountered would be the equivalent of 24 gusts of 10 ft. per second. The majority of the gusts would, in practice, be met with at low altitudes during the climb and descent while the fuselage is at a low pressure differential.

This three-hour flight is simulated in the tank by loads, applied automatically, in the following sequence, which is completed in four minutes.



Vertical steady flight loads and repeated gust loads are applied to the wing, and to the tail end of the fuselage, by hydraulically actuated jacks. Load sequencing is automatic.



The control room, showing in the foreground the water pumps which pressurise the fuselage and in the background the hydraulic pumps supplying the wing and tail-load actuating jacks.

Steady flight loads are applied to the wings, thus raising the aircraft off the supporting undercarriage. Subsequently, additional gust loads and pressurisations are applied as follows: (*a*) ten gusts with fuselage unpressurised representing take-off and initial climb; (*b*) four gusts during which fuselage pressure builds up to a maximum pressure differential representing normal climb; (*c*) four gusts at full pressure differential representing high altitude cruise; (*d*) six gusts during which the fuselage pressure differential falls from maximum to zero, representing descent. Finally, the flight loads are removed and the aircraft sinks back on its undercarriage.

While the tests are in progress the tank works continuously night and day until a flight time of 1,500 hours is completed; this takes less than 48 hours. The tank is then emptied and the aircraft inspected before the test is renewed for a further 1,500 hours.

The whole sequence of operations is controlled automatically from a control room near the tank, shown in the accompanying illustration. The test sequence is put into motion by push-button switches controlling the pumps for the water tank and the hydraulic jacks. The number of gusts and the number of flights are recorded on electrical counters; the pressure in the fuselage is plotted on a recording pressure graph and the sequence of the test is shown on a panel of lights. No action is normally required by the operator who has at his disposal an emergency switch by means of which he can instantly release the pressure in the fuselage and remove the load from the wings and tail.

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AIRCRAFT PASSENGER SEATS

Safety with Acceleration of 9g

British European Airways' future fleet of Viscount 802 air-liners will be fitted with a new type of aircraft passenger seat designed and constructed by Short Brothers and Harland Limited, Queen's Island, Belfast. The new seat is designed to withstand an acceleration of 9*g*, facing forward or aft. When forward facing, in an emergency landing, the back of the seat, which is padded, will fold forward when struck behind.

The Short seat constructed in tubular and sheet metal, is claimed to combine high strength with low weight (60 lb. plus 3 lb. for a double seat, 90 lb. plus 2 lb. for a triple seat), and to offer a high degree of comfort, the seat cushions and back squabs being in foamed plastic lying on Terylene sheets attached to the structure. Double and triple seat units can be folded and stowed against the side of the fuselage, thus readily converting the cabin for freight carrying, without the use of tools. All the sub-assembly units are interchangeable. The seat back can be adjusted within a total angular travel of 15 deg. in six stages. Retractable tables are fitted to the rear face of each seat back, and are designed to be clear of the seat in any angular position.

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HEAVY DUTY RELAY

Besson and Robinson, Limited, East Industrial Estate, Harlow, Essex, are now marketing a general purpose relay with a continuous rating of 20 amperes at 250 volts alternating current. It embodies an arrangement of two pole change-over contacts so that all single phase switching requirements can be met, and a limited number of coils with a consumption of less than 5 VA on alternating current and 2½ watts on direct-current. The frame is fully laminated and the construction is such that silent operation is obtained on alternating current. The stainless steel armature shaft is borne in Oilite bearings so that rapid operation is possible for very long periods. The relay is "tropicalised."

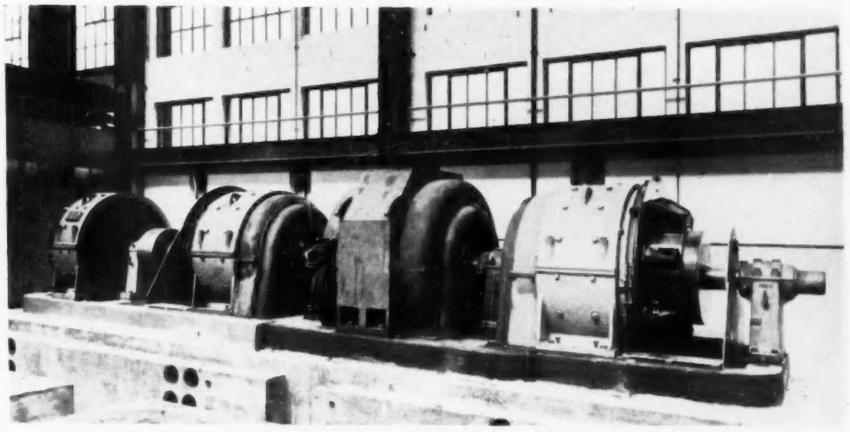

Fig. 1 One of the two motor-generator sets in the medium-power short-circuit testing station at the Witton works of the General Electric Company, Limited.

SHORT-CIRCUIT TESTING STATION

MEDIUM POWER INSTALLATION AT WITTON

Although there are a number of stations where high power tests on alternating current switchgear can be carried out within the framework of the Association of Short Circuit Testing Authorities (A.S.T.A.), medium and direct-current powers are not catered for to the same extent. This is the more surprising since a wide variety of direct-current switchgear is in use, especially for traction purposes, while the increasing size of rectifier substations capable of delivering large fault currents would, it would seem, demand test equipment which can provide short-circuit currents of corresponding magnitude.

The General Electric Company, Limited, have therefore established a new short-circuit testing station at their Witton works to provide a corresponding service for medium power equipment to that available in the A.S.T.A. stations. This not only enables high speed direct-current traction circuit-breakers for voltages up to 3,000 to be tested, but the properties of alternating and direct-current contactors, high rupturing capacity cartridge fuses, switch-fuses, fuse-switches, marine distribution equipment and domestic switchgear to be investigated.

TEST REQUIREMENTS

It is obvious that such a wide range of equipment possesses equally varied operating characteristics, although the final criterion is that of effective arc extinction. The principal differences between the equipments to be tested are the media in which this extinction takes place; and whether it is necessary for the arc to be extinguished in the first half cycle of operation or may be allowed to persist for several. In the first case the test plant must permit the prospective short-circuit current to have a high degree of asymmetry, while in the other cases it must be capable of maintaining a steady fault current during the arcing period.

To meet these requirements the new test plant at Witton has been designed to provide alternating current up to about 15,000 amperes at 1,700 volts and to enable tests to be made at high or low power factors at different frequencies and recovery voltages. It also possesses sufficient stored energy to enable the necessary degree of severity to be imposed on the equipment under test.

The plant is further capable of delivering adequate power at any operating voltage up to 4,000 direct-current and short-circuit currents up to 40,000 amperes and the testing circuit is arranged to give suitable characteristics, such as the time constant and form of recovery voltage. Finally, the usual alternative arrangements for short-circuit testing are included in the plant, so that the short-circuit can be applied under controlled and predetermined conditions.

CONSIDERATION OF TYPES

Before establishing the station at Witton the alternatives of using static or rotating test plant were carefully considered. Rotating plant in the form of a motor-generator was finally selected, since it provides flywheel-stored energy, independence from mains fluctuation, the advantages of a wide frequency and voltage range and ease of control. Moreover, two large motor-generator sets, which were and still are used for testing mercury arc rectifiers were available in the Rectifier Works at Witton and could therefore be employed for testing medium powered apparatus.

Buildings for the new testing station were therefore erected as close as possible to the motor-generator sets in the Rectifier Works and are connected to the latter by heavy current busbars, which are run in trunking. A smaller building houses a master breaker, which is used for back-up protection during alternating current testing, while a third building is available for storage.

The station building itself is subdivided into four parts: the test bay proper; a switching bay for setting up the test circuit constants; an observation and instrumentation room housing the control desks; and a combined photographic room and office.

The two motor-generator sets, one of which is illustrated in Fig. 1 each consists of four machines on a common shaft. These machines are a 750 h.p. direct-current driving motor, a 3,000 kVA three-phase alternator and two separately excited 1,500 kW direct-current generators. The driving motors, which are controlled from a common panel so that they can be started independently, are capable of stable operation over a wide range of speeds and loads. As a result, the salient-pole alternators, which are excited from independent motor-generator sets, have a correspondingly wide frequency range. The alternator windings are sub-divided so that various star and delta connections can be made. The series-star connection provides 1,760 volts at 750 r.p.m. The fully compensated 1,500 kW dynamos can each supply direct current at 1,000 volts; and are separately excited from the rectifier which supplies the driving motors.

SWITCHING ARRANGEMENTS

As will be seen from Fig. 2, which is the main circuit diagram of the station, the switching arrangements can be divided into four sections: setting up circuits; circuits for protecting the

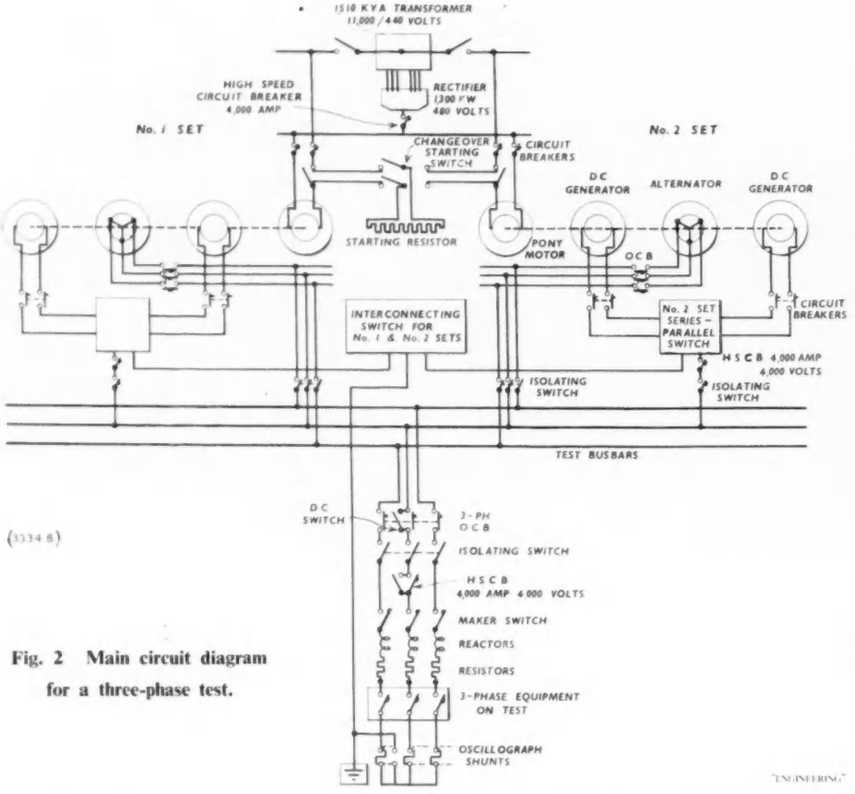

Fig. 2 Main circuit diagram for a three-phase test.

machine; the protecting and making connections at the station; and the control gear. The equipment for setting up the generators in series, series-parallel or parallel and the alternators in star or delta and series or parallel consists mainly of heavy busbar sections with change-over links and isolators. The outputs of both the dynamos and alternators of the motor-generator sets are connected to oil circuit-breakers for protection purposes, while each of the four dynamos has its own circuit-breaker.

Power is transmitted from the machines to the testing station by an overhead system consisting of three sets of 4 in. by $\frac{1}{4}$ in. copper busbars, the middle set being used for either alternating or direct-current testing. This system can be isolated for safety and maintenance; and there are also by-passes to prevent a heavy direct-current arc being produced on the master oil switch. Direct-current protection of the test supplies is provided by a local high-speed direct-current circuit-breaker.

The assistance banks, reactors and other equipment which determine the characteristics of the circuit are housed in a screened bay adjoining the test enclosure, links being provided to give any desired series or parallel arrangement. The test circuit terminates on an insulated panel in the test bay proper on which the necessary instrumentation and oscillograph shunts are mounted.

CONTROL ROOM

The control room, which owing to the small size of some of the equipment to be tested is placed as close to the test position as safety permits, is illustrated in Fig. 3. It contains a desk on which the controls for switching the making sequence, operating the auxiliary supplies for actuating the equipment under test and initiating the short-circuit arc are mounted. There is also a master controller which enables the whole plant to be shut down in emergency. The desk incorporates a cathode ray oscillograph as well as a six-element Duddell oscillograph, which enables current, voltage, power and mechanical movement to be measured and recorded simultaneously. Recording cameras are also mounted alongside the desk. A special feature of the Duddell oscillograph is the

Fig. 3 Control room at the medium-power short-circuit testing station.

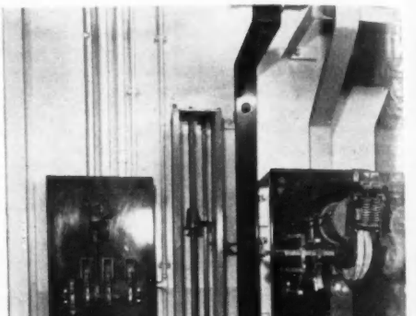

Fig. 4 The falling weight and rotary relay mechanism.

intensification of illumination during exposure. It is also equipped with a camera drum, which can be driven at a wide range of fast and slow speeds; and a tachometer, which enables the speed to be adjusted to suit the timing of the falling weight mechanism which controls the duration of the short-circuits.

FALLING WEIGHT MECHANISM

While a short circuit is being applied the operation of the station is controlled by a falling weight and a rotary relay mechanism (Fig. 4). The falling weight selects the time intervals between the successive stages of a test and then by releasing the catch of the rotary relay cuts off the short-circuit current in from 4 to 25 cycles, if this has not already been done by the successful operation of the equipment under test.

The weight itself is released by a mechanism, which is actuated by the "maker" contactor and the distance it falls before releasing the catch of the relay can be adjusted to vary the duration of the short circuit. The rotary relay controls the operation of the master circuit-breakers and the field suppression systems of the motor-generator sets. It also closes the shutter mechanism of the Duddell oscillograph at the end of the short-circuit period.

Protection of the testing staff is ensured by providing expanded metal and glass screens at the control desk and by preventing access to the test bay and test plant whenever the main generator circuits are alive. Automatic interlocks on all the doors leading to the bays open the master circuit-breakers and render the main circuit dead. Auxiliary alternating-current contactors with special insulation and supplied from an isolating transformer operate the master circuit-breakers, oscillograph mechanisms and timing gear to prevent the main generator voltage penetrating to any of the control room circuits. The test plant is equipped with earth leakage protection on the main and field circuits and with over-current protection. The fields of both the alternators and direct-current generators can be suppressed and a manual switch enables the whole plant to be made "dead" in emergency.

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We regret that two misleading statements appeared in our issue of December 23, 1955. In the Weekly Survey note on the I.Mech.E. Lubrication Group the reference to "a separate society of locomotive engineers" should have been to lubrication engineers. In the Human Element note on accidents, the report quoted was that of the Chief Inspector of Factories, not the Chief Inspector of Mines.

BENDING CONDUIT

Portable Hand Tool

As it is rare that a run of electrical conduit is straight throughout its length, some means has to be found to make the required bends without distorting the tubing. A hand tool for this purpose—the "Redege" Benfield bender—has been introduced by the National Electric Products Corporation, Gateway Center, Pittsburgh, Pa., U.S.A., and is shown in the illustration. Three models are made: for thin-wall tubing up to 1 in. in diameter and thick-wall tubing up to $\frac{3}{4}$ in.

The arrow marked on the hook shows the commencement of the bend and also gives the take-up distance for a right-angle bend. Thus, when a stub of given length is required, the length of conduit projecting beyond the arrow is the required length less the take-up amount. This varies for the different sizes of tool, but in each case it is the height of the tool from the handle socket to the rim; therefore, by passing the conduit through the socket, the point which has to come opposite the arrow can be marked.

When it is required to make one bend at a particular distance from another (both being in the same plane), the star point forms the marker. An example of this is when a flat-bottomed U is being made and the distance between the legs is fixed. One bend is made and then the tool placed on the conduit so that the star point comes at the position required for the outside of the second leg, and the second bend made.

The simplest way of making a bend is to lay the conduit on the ground and pull the tool upwards, using a foot on the serrated projection to give additional leverage. When the handle is vertical, a 45 deg. bend has been made and full operation is through an angle of 98 deg. to allow for spring in the conduit. If the bend is too great, it can be corrected by sliding the tool up the conduit and using it in reverse; a special groove is provided for this. The tool is made from a pearlitic cast iron and carries a five-year guarantee. The models vary in weight from $2\frac{1}{4}$ to $8\frac{1}{4}$ lb.

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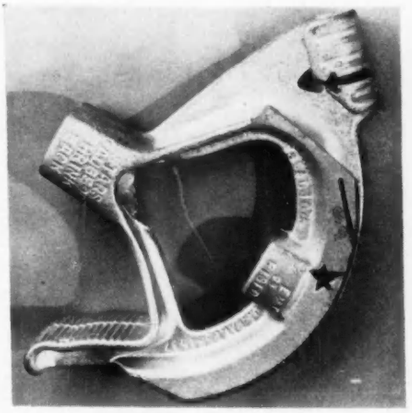
ELECTRO-HYDRAULIC CARGO WINCH

The accompanying illustration shows a self-contained electro-hydraulic cargo winch, which has recently been designed by Messrs. Vickers-Armstrongs, Limited, Broadway, Westminster London, S.W.1. Its objects are to eliminate the piping between the power pump and the deck unit, which is the main disadvantage of the hydraulic drive; and to combine the flexibility of steam with the simplicity of direct-current operation. In addition, the winch is capable of a high rate of acceleration under both full and light load conditions, requires the minimum space for housing, is free from complicated control arrangements and automatically holds the weight in the event of a power failure.

As regards layout, the deck unit incorporates



The Redege bender can be used for shaping thick or thin-walled conduit.

a main haulage barrel which is mounted between two cast-iron side frames and is driven through single helical reduction gearing by a hydraulic motor. The flanges of this barrel are shrouded in the side frames to prevent rope jamming. Warping drums are also provided.

The hydraulic motor is supplied with oil from a pump which is direct coupled to a watertight electric motor, a valve being fitted to control the direction and speed of operation. The hydraulic and electric motors and the pump are all mounted on a fabricated steel bedplate as are the main side frames and barrel. The hand-operated starter for the electric motor, which is the only separate item, can be installed in the engine room, in a deckhouse or alongside the winch.

The pump, which is of the variable delivery type, is fitted with automatic pressure control and is normally held in the full delivery position by a spring. When the pressure rises to a given value this spring, against which a ram in the pressure lines acts, is compressed and the pump delivery is reduced and continues to decrease until the "no-delivery" position is reached at a pre-set pressure. The hydraulic motor is of the fixed displacement type so that its speed is always proportioned to the volumetric delivery of the pump. As a result the electric motor, hydraulic equipment and mechanical components are all protected from overloads, since the maximum speed is reduced at the heavier loads. Multiple control springs are used to make full use of the power available at all speeds. Manual control is effected by a four-way open-centre piston valve which is operated by a lever.

An automatic hydraulically-operated brake of the internally-expanding type is installed in one of the side frames. Its drum is incorporated in one of the flanges of the winch barrel and braking is applied by a spring. The brake is automatically released by hydraulic pressure on a ram immediately the winch is operated. This arrangement ensures that the load is held when the directional valve is in the neutral position or in the event of electric or hydraulic power failure. It also gives added protection when cargo is being loaded. An auxiliary foot brake is provided.

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V.H.F. BROADCASTING

Extension of B.B.C.'s Services

The Welsh Home Service of the British Broadcasting Corporation has been transmitted on a frequency of 94·3 megacycles from the Wenvoe station, near Cardiff, since December 20. The effective radiated power is 30 kW and is horizontally polarised. The new service reinforces the existing medium-wave transmission on 341 metres and will also ensure freedom from foreign interference. Early in the new year the effective radiated power will be increased to 120 kW.

Owing to the late delivery of equipment the erection of the permanent aerials at the North Hescary Tor and Rowridge television stations has been delayed. It will therefore not be possible for them to become fully effective until April and May, 1956, respectively. For a similar reason the opening of the very high frequency sound transmitting stations at Meldrum and Divis will not take place until March, 1956.

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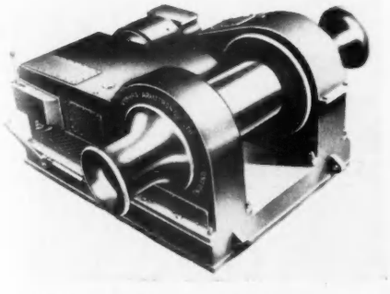
PORTABLE CONVEYOR

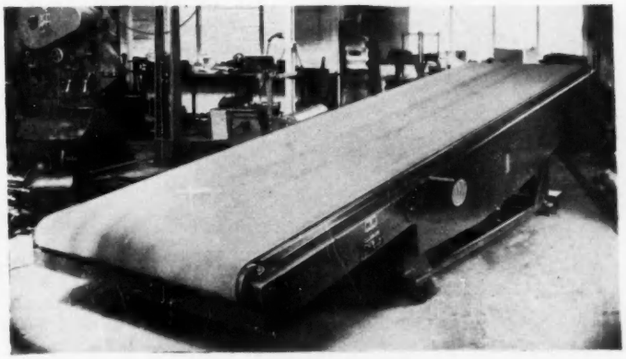
Wide-Belt Unit Adjustable for Height and Tilt

The wide-belt conveyor shown in the illustration was developed by the Clarke Ellard Engineering Company, Limited, Works-road, Letchworth, Hertfordshire, for transporting the body panels of motor cars between presses in the factory. Conveyors for this purpose vary in width from 3 ft. to 5 ft. and in length from 12 ft. to 25 ft. As presses are not always the same height, the conveyor height can be adjusted at both ends separately by a gear-and-link mechanism operated by the handle which can be seen in place in the illustration. The variation obtainable is from 25 in. to 40 in. above ground level when horizontal, or 18 in. to 48 in. when tilted.

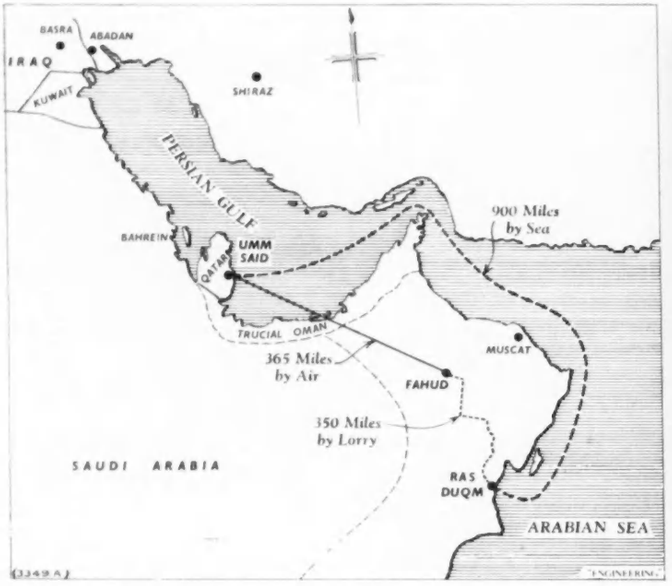
The belt is rated for a loading of 50 lb. per square foot and operates at a maximum speed of 50 ft. per minute. Guiding devices are fitted to prevent sideways movement, or tracking, of the belt. The driving motor and an automatic tensioning mechanism are enclosed within the frame work, which thus presents a smooth exterior. No part projects above or beyond the belt and so over-size or irregular shaped articles can be conveyed without risk of damage. Start and stop control buttons are fitted on both sides. The framework is mounted on four ball-bearing swivel casters, so that the conveyor can be pushed into the exact position required. When there, it can be locked by four hand-operated jacking screws. There are also lugs for transporting the whole conveyor by crane.



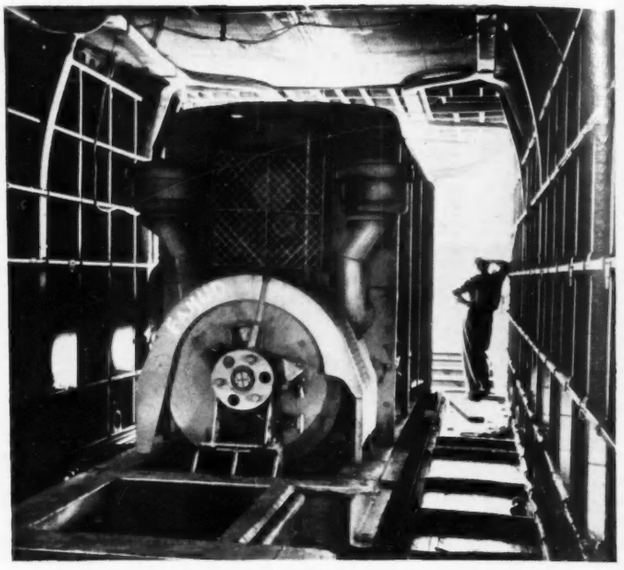
Vickers-Armstrongs self-contained electro-hydraulic cargo winch, designed to have the flexibility of a steam-operated machine.



Designed for a belt loading of 50 lb. per sq. ft., this conveyor unit can be pushed into position between two machines and the height and inclination adjusted to suit both.



The only practical land access to Fahud is from Ras Duqm on the south coast—900 miles from Umm Said by sea, followed by 350 miles across desert. In contrast, the air distance is 365 miles—just over 2 hours flight.



One of the four Paxman engines installed in the hold of the Universal Freighter. Air transport enables large, complete units to be taken over rough country with little risk of damage.

AIR TRANSPORT OF HEAVY OIL-WELL DRILLING EQUIPMENT

129 TONS IN 10 DAYS OVER INACCESSIBLE DESERT

An air transport operation unique in the history of aviation has been carried out in South East Arabia. Prospecting for oil by the Iraq Petroleum Company had indicated the possibility of a valuable " strike " in a desolate region.

The heavy oil drilling equipment could only be moved overland by the use of specially designed surface transport, involving great expense and prolonged transit times. It was decided, therefore, to transport all this heavy equipment by air using a Blackburn Universal air freighter. The operation was initiated by the Iraq Petroleum Company and the aircraft manufacturers, Blackburn and General Aircraft, Limited. The help of Hunting-Clan Air Transport was enlisted to provide aircrew and local operating knowledge.

The equipment had to be transferred from Umm Said in the Qatar Peninsula, an equipment base and a well-established oil port in South East Arabia with permanent buildings and a well-marked airstrip of compacted sand and gypsum, to Jebel Fahud in the Sultanate of Muscat and Oman, a rocky formation lying about 100 miles south-west of the mountains of Oman, which geological surveys indicate as a promising site for oil exploration. The airstrip at Fahud is a levelled stretch of desert consisting of a limestone base with an overlay of small stones and sand about 4 in. deep.

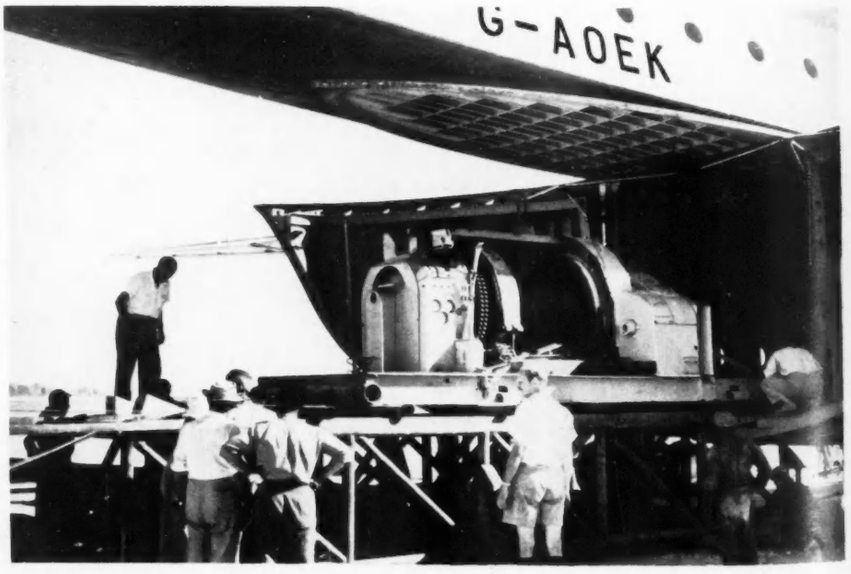
Fahud is separated from the east coast of Oman by a range of mountains known as the Jebel Akhdar which form an effective barrier to overland transport from the East. It is cut off entirely on the west by a desert known as the Rubal Khali. Land access to the north entails a difficult desert crossing—these difficulties, however, might have been overcome but for the fact that this northern route would have to pass through or close to the Buraimi Oasis, which is at the moment subject to a disagreement between Saudi Arabia and the British Government, the latter acting on behalf of the local Sultans.

The only practical land access to Fahud is from Ras Duqm on the south coast, which involves a journey of 900 miles from Umm Said by sea, followed by an arduous journey of 350 miles across the desert, the whole trip taking more than two weeks. Moreover, there is no deep water harbour at Ras Duqm so that loads must be transferred off-shore to landing craft. With these craft a landing is made through the surf on to the sandy beach, after which the loads are manhandled on to desert transport.

The air distance between Umm Said and Fahud is 365 miles—just over two hours flight. As no transhipment of loads is required, the air journey is much easier than the surface journey and it involves no risk of damage to the equipment being moved. From the beginning of operations in the Fahud area Dakota and Bristol Freighter aircraft have been used to move valuable equipment and for bringing in personnel, but the only aircraft capable of fulfilling the requirements of the large indivsible loads was the Blackburn Universal.

In nine flights the Universal transported all the requisite 129 tons of equipment and completed the operation ahead of schedule. Throughout the airlift the only adjustments and replacements were of a minor character, such as were expected on a pioneer operation of this type. Preliminary information indicates an average loading time of 150 minutes and unloading 50 minutes.

Details of the main load items transported are given below. In the first four journeys, the four main Paxman Diesel engines which provide power for lifting the drill pipe were transported. Each engine weighs 7¼ tons and is 21 ft. 6 in. in length, 4 ft. 6 in. wide and 8 ft. 6 in. high. The starter trolley accompanied the first engine, and



The front half of the draw-works—16 tons, 21 ft. 11 in. long, 8 ft. 3 in. wide, 7 ft. 5 in. high—is unloaded at Fahud.

with the fourth engine went the draw-works transmission unit, that is, the drive gear connecting the Diesel power units with the draw-works assembly.

The draw-works—the machinery used for lifting the drill pipe, which may be several thousand feet long, to enable a new section of pipe to be added—was transported in two halves. The rear portion, 21 ft. 6 in. long, 9 ft. wide and 8 ft. 6 in. high and weighing 12 tons, went first. The front half of the draw-works, of the same overall dimensions but weighing 16½ tons, was the last piece of equipment to be transported.

On the next journey, after the rear half of the draw-works had been delivered went the 6 ton travelling block and skids brake, followed by the 5 ton rotary table, pump base, crown block and silencer. The rotary table is the drive unit for the "kelly"—the square shaft at the top of the drill pipe by which the latter is rotated—and is 8 ft. long, 4 ft. 9 in. wide and 2 ft. 6 in. high.

On the penultimate journey the mud tank was delivered—the tank used to hold the liquids which are forced down the drill pipe during the drilling operation to cool the drill bit and to carry away the rock chippings. This tank is 28 ft. 3 in. long, 8 ft. 9 in. wide and 6 ft. 6 in. high, and weighs 3½ tons.

In addition to the main loads detailed above, a number of smaller components were carried; the payload on each journey ranged from 10 tons to 16½ tons, and in all a load of 129 tons was transported in 10 days.

REFUSE DISPOSAL

MECHANICAL HANDLING PLANT AT GREENOCK

The new refuse-disposal plant which was opened recently at Ladyburn, Greenock, replaces a refuse destructor that was 48 years old. The new plant will serve a population of 77,300 and is capable of dealing with all the town's industrial and domestic refuse. The old destructor at Dellingburn was extensively damaged by bombing in 1941, and in recent years has been unable to cope efficiently with the town's refuse. In October, 1944, a report was submitted to the Corporation noting that the age of the plant caused a considerable loss of efficiency and required an excessive amount of repair and maintenance work. The restrictions of the site prevented any extension of the plant and the report advised that a new plant on a different site should be built. The site at Ladyburn was selected and acquired from the Railway Executive and the Greenock Harbour Trust. The tender submitted by Heenan and Froude, Limited, Worcester, for the plant and machinery was accepted and separate contracts were signed for the preparation of the site, piling, foundations, roads, buildings—except structural work—reinforced-concrete work, water, drainage, lighting, etc. The erection of the refuse-disposal plant forms the first part of a scheme which will ultimately bring the whole Cleansing Department on to the same site and will also provide for garage accommodation, repair shops, two dwelling houses and offices.

125 TONS SORTED AND TREATED IN 8 HOUR SHIFT

The cost of the first part of the scheme, comprising the refuse-disposal plant, is made up as follows:

	£
Site preparation, piling, etc.	45,000
Plant and machinery	125,000
Buildings, etc.	65,000
Other works, including purchase of land	40,000
	£275,000

The plant will deal with 125 tons of refuse in an 8 hour shift and the incinerator is capable of burning 75 tons of tailings in the same time. The aim has been to provide efficient and hygienic treatment of the refuse throughout the stages of mechanical handling, screening, salvage recovery and incineration.

The plant occupies an enclosed site at the east end of the Burgh and lying between the Clyde, the Ladyburn, Port Glasgow-road and Pottery-street. Vehicles will enter and leave the works by the Pottery-street gates, which are located away from the main road traffic. The administrative buildings are being built close to these gates, together with a weighbridge and office located just inside the entrance gates, and a reinforced-concrete road rises from this position to the first floor of the tipping house. The plant is housed in three main buildings connected by conveyor galleries; there is also an electrical sub-station on the site.

Loaded vehicles coming on to the site are weighed, and then passed to the elevated tipping platform where the refuse is discharged into two reception and storage hoppers, which have a combined capacity of 150 cub. yards. From these it is transferred by variable-speed conveyors, 8 ft. wide, to the connecting and elevating belt conveyors. This arrangement will permit a reception hopper to be closed down for maintenance work without interfering with the operation of the rest of the plant.

From the reception house a belt conveyor, 42 in. wide, carries the refuse up to the screening and salvage house. There it is fed into a large rotary screen, mounted horizontally and fitted internally with a helical guide which propels the refuse over the perforated plates, and the separated dust and cinders fall into reinforced-concrete storage hoppers. The capacity of the hoppers is 30 tons for dust and 5 tons for cinders, and discharge doors permit loading away into vehicles at ground-floor level.

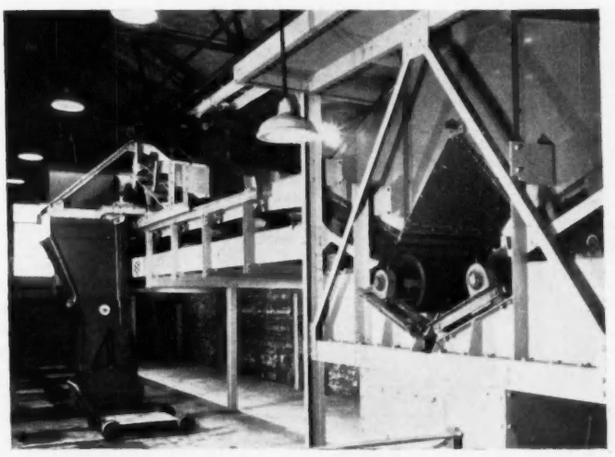
The screen discharges the retained refuse on to a 42 in. wide belt conveyor which displays the tailings for sorting and picking, an operation that is assisted by an overband electro-magnetic separator above the picking belt. The separator extracts tins and ferrous metals which fall to a large enclosure at ground level where a Heenan all-geared metal baler, with an output of about 16 bales an hour, is situated. The bales measure approximately 18 in. by 12 in. by 8 in. and weigh about 50 lb. A motor-driven Smith paper press has been installed in the salvage room near the enclosure, and paper is fed into it from the picking station above.

SALVAGE

Of the remaining salvageable items (comprising rags, non-ferrous metals, bones, bottles, etc.) some will be fed through chutes to storage bins at ground-floor level and the rest stored in bags on the picking floor for removal to vehicles below at intervals. From the picking floor the conveyor belt extends into the incinerator house where the tailings are raised to a central point and thence discharged by a two-way chute to the 36 in. wide distributing conveyors over the furnace platform. Each belt is provided with a travelling tripper, controlled by push button. A short reversible cross belt and chutes are used to deliver the tailings into the top feed openings of the incinerators, or, if necessary, on to the platform for hand feeding.

The two Heenan incinerators are steel cased, with hydraulically operated grates. Each unit has five cells with a separate combustion chamber. The location of the incinerators at first-floor level facilitates the discharge, quenching, and handling of the clinker and has made it unnecessary for machinery to be installed underground. Each of the ten grates is supported on a carriage which is hydraulically withdrawn for clinkering, and the clinker then falls into skip bodies in enclosed chambers at ground level. There is one chamber for each grate and a stillage system of skips has been incorporated. The falling clinker is caught and stored in a convenient position for quenching by water jets and subsequent disposal to the clinker yard, prior to removal from the site. A battery-

The incoming refuse first passes through screens where dust and small clinkers are extracted before moving on to the picking belt shown here passing below the magnetic separator.



After the picking belt, all refuse not taken for salvage passes to the incinerators. The "tailings" can be charged into the incinerators automatically by a travelling tipper, or by hand.

operated truck transports and tips the skips and afterwards replaces them in the stillage position. For the disposal of bulky combustible materials large doors are provided at ground level in the downtakes immediately beneath the incinerator combustion chambers.

The hydraulic system consists of duplicated high-pressure pumps and a Fielding & Platt accumulator coupled to control valves, cylinders and piping, the control valves being operated from the front of the furnaces. The quenching chambers and furnace casings are ventilated and cooled by a system of ducts connected to the intake of the forced draught fans, while the furnace castings are cooled by an air supply tapped off the pressure side of the forced draught. The gases leaving the incinerators pass through a flue system to a water-type dust catcher and thence by a short flue to the chimney. The solids collected by the dust catcher are removed by gulley emptier in the form of sludge. The chimney is circular and of brick construction, with an internal diameter at the top of 8 ft. 6 in. and rising to a height of 180 ft. above ground level.

To improve working conditions, dust-collecting plant has been fitted in the tipping and screening sections. Twin units are installed to deal with dust rising from the refuse-reception hoppers, and a third set controls the fine dust at the screen inlet and outlet chutes. The dust is collected by filters in separate sections of the buildings.

The electric power for lighting, driving the motors and for energising the magnetic separator is obtained through a transformer station situated within the site. A low-tension switchboard in the screen and salvage house distributes current to each main section of the plant where local distribution boards are provided. For safety, a system of sequence interlocking has been incorporated with the motor starters.

275 KV SWITCHING STATION AT DRAKELOW

ADVANCED DESIGN FOR THE SUPER-GRID

As mentioned on page 666 of ENGINEERING, for November 11, 1955, the alternators at the Drakelow A power station of the Central Electricity Authority, near Burton-on-Trent, are connected through 72 MVA, 11·8/141·6 kV transformers to the 132 kV switching system. This system is in turn connected through two 120 MVA, 132/275 kV English Electric transformers to a switching station which covers an area of more than 54,000 sq. yd. and will control 14 circuits of which seven are already installed.

The station, part of which is shown in the illustration, is being equipped by A. Reyrolle and Company, Limited, Hebburn, Co. Durham. It is of the low double busbar type, the busbars being of rigid copper tube 3 in. in diameter. These are carried by the isolators and by intermediate post insulators. Both insulators and post insulators are mounted on reinforced concrete pedestal structures to give the necessary ground clearance to the busbars, while the circuit connections consist of flexible conductors, which cross above and at right angles to the busbars and are strained between reinforced concrete A-frames. Riser connectors from the busbar selector isolators and down-dropper connectors to the circuit-breaker and its associated equipment complete the circuit.

At present the main and reserve busbars are each single section, with a busbar coupler circuit-breaker between them. Ultimately, however, the main busbar will be divided into three sections with busbar section and busbar coupler circuit-breakers. Circuit-breaker by-pass isolators are not provided, but there are facilities for by-passing a circuit-breaker by flexible conductor loops and for isolating it by removing connector sections. The circuit can then be controlled by the busbar coupler circuit-breaker and extended maintenance of the circuit-breaker undertaken, if required, with the circuit still in commission.

CIRCUIT BREAKER DESIGN

The circuit-breakers are of Reyrolle's air-blast design with a maximum current rating of 1,200 amperes and a making and breaking capacity of 7,500 MVA. They are mounted on reinforced concrete pedestals to give the necessary clearance from live metal to ground and thus to avoid the need for safety screenwork.

Each phase of each circuit-breaker is identical, and all three are coupled together by series break arm operating shafts and by air piping. These ensure that all three phases operate simultaneously, even in the event of failure of the closing or tripping valves of any phase. Each phase consists of three hollow support insulators which are mounted on a common bedplate. Each insulator contains a porcelain blast pipe and is surmounted by two interrupted units in V-formation, so that there are six circuit interrupters in series per phase. Correct voltage distribution across the breaks is obtained by shunting each break by a tubular condenser, which also forms part of the blast tube to the circuit-breaking contact and nozzle assembly.

There are three blast valves per phase, all of which are coupled together by a heavy section tubular torque shaft and are operated by a single piston type air motor. The compressed air is stored at 330 lb. per square inch gauge in one receiver per phase, and is controlled by a pilot valve arrangement which is initiated by a relatively small operating magnet. Economy in air consumption is ensured by a changeover valve which is operated by the series isolator mechanism. When the isolator is opened sufficiently, this mechanism transfers the air pressure to the other side of the blast valve motor and closes the valve rapidly.

The series break sequential isolator, which is an integral part of the circuit-breaker, is of the centre rotating type and bridges the gap from the end interrupter to a terminal post which is carried on the bed plate. Its arm is carried on a porcelain insulator which is rotated by a double-acting piston type air motor. This motor is supplied with air, when opening, from the nearest blast pipe of the circuit-breaker so that it only operates after the blast valve is opened. In closing, the circuit is made on the series sequential isolator at an appropriate speed. The closing valve is identical with the tripping pilot valve mentioned above.

Adequate interlocks are provided in the air system to prevent erroneous operation of the circuit-breaker under all operating conditions.

Precautions have been taken to prevent any contamination of the numerous plain insulation surfaces exposed to air inside the circuit breakers. The first of these is to have no insulation close to the arc, which is completely contained in its own metal chamber. In fact the nearest insulation is some distance from the arc on the windward side of the air blast, so that contamination from the gaseous products is eliminated. The second is that as far as possible only porcelain is used for insulation, including the main blast pipes. The sole Bakelised-paper insulation employed is in the voltage distribution condenser. Thirdly the whole of the internal insulation surfaces are continually swept by very dry conditioning air, which is expanded from the storage pressure to a few pounds above atmospheric pressure.

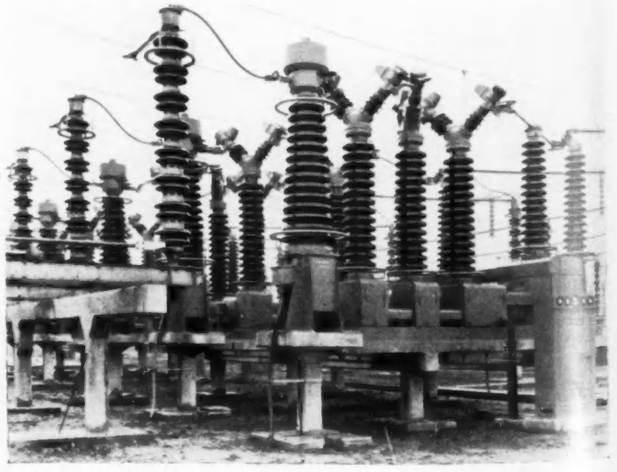
All the controls and air system isolating valves, the pressure gauge, the conditioning-air reducing valve, the choke and conditioning-air flow-indicator, the local-remote changeover switch, the automatic shut-down valve, the emergency trip valve, and the supply fuses and links are contained in a separate floor-mounting control cubicle which is mounted parallel to one phase of the circuit-breaker.

ISOLATOR DESIGN

The isolators, which have been manufactured by the General Electric Company, Kingsway, London, W.C.2, to a standard design developed for the Authority, are of the double rotating, two-post pattern, with a special ball and socket type of high pressure contact. They are all provided with power-operated mechanisms. The busbar selector isolators are arranged in tandem while the three phases of the circuit isolators are ganged side by side.

Only the busbar selector isolators are arranged for remote operation from the control room, but they are all fully interlocked with the circuit-breakers to prevent operation unless the appropriate circuit-breaker is open.

The post-type current transformers are of Reyrolle manufacture and are mounted independently of the circuit-breakers. The primary conductor is of U-formation and is fully insulated for the system voltage with condenser grading layers and a metal earth screen. The cores and secondary windings are of the orthodox continuous ring type, and are mounted in a steel chamber over the bottom section of the U-primary, the top of which is contained in a single porcelain insulator surmounted by a metal connection chamber. The whole assembly is vacuum-dried and oil-filled condenser type oil is used. The top chamber is provided with a nitrogen sealing device in which a breather is incorporated. Four or five independent secon-



One of the 7,500 MVA 275 kV Reyrolle circuit-breakers which are being installed in the super-grid switching station at Drakelow, Burton-on-Trent.

dary windings are provided for instrumentation and protection services. These have suitable tapping and test windings to give the maximum facility for interchangeability and for site testing.

The voltage transformers, which are of the capacitor type, are also of Reyrolle manufacture. Greater compactness is obtained than if the electromagnetic type had been used and they also have a high impulse strength. The actual transformer core and winding assembly are relatively small since they are designed for operating at a much lower voltage than the line voltage, and are coupled to the line by a capacity divider which is incorporated in the construction and is connected between line and earth. The condenser section between the transformer primary high-voltage winding and the line is contained in two separate oil-filled porcelain housings. These are mounted above the earthed metal chamber which accommodates both the transformer and the condenser between the high-voltage winding and earth, i.e., in parallel with the high-voltage winding. The metal chamber is filled with oil, but has two air-filled sections with access covers in which the spark-gap device and the secondary terminals and fuses are accommodated.

COMPRESSED AIR EQUIPMENT

The compressed air for operating and for conditioning the internal insulation of the circuit-breaker is obtained from batteries of 30 cub. ft. per minute compressors, which deliver air at a pressure of 600 lb. per square inch gauge to batteries of main storage cylinders, each with a capacity of 38 cub. ft. The air is stored at a higher pressure than the operating pressure for the circuit-breakers so that the risk of water condensation in the 330 lb. per square inch pipework and local receivers is practically eliminated. The reserve storage capacity is thereby increased and the rate of re-filling the local air receivers is accelerated. The local air receivers are sufficient for two make-break operations per circuit-breaker, and the main air receivers provide additional capacity which is available to any circuit-breaker that requires it.

The switchgear is controlled from the power station by 110 volt direct wire control. The control board is of the cubicle type with separate control cubicles for each circuit, a mimic diagram and the usual instrumentation and synchronising facilities. The protective relays are mounted in separate cubicles, accommodated in the auxiliary plant building on the switchgear site.

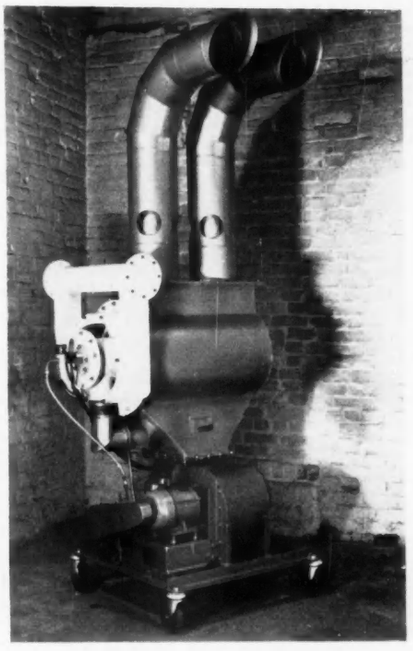
* * *

FURNACE INSPECTION

Improved Protective Glass

When inspecting steel furnaces, a blue glass of the cobalt type is usually used as a shield. This reduces the glare to an acceptable level and, since it has a high red and blue transmission while absorbing green and yellow, enables the temperature of the furnace to be judged accurately by the two-colour pyrometry effect. Unfortunately it also transmits rays from the ultra-violet and near infra-red portions of the spectrum, which can cause harm to the human eye.

Working in conjunction with the British Iron and Steel Research Association, a new glass, CSS, has been developed by Chance Brothers, Limited, Smethwick, Birmingham, 40. This is a compromise between cobalt glass, with its high temperature discrimination properties, and a green glass which gives good protection but poor discrimination. A sheet 2 mm. thick of this new glass has a total heat transmission of 0·0% per cent. Measurements made by the National Physical Laboratory show that with a 2 mm. sheet of the CSS glass, 61 chromaticity steps can be detected between 1,750 deg. K. and 2,[illegible] deg. K., using a black-body radiator. With a similar sheet of cobalt glass, 82 steps are detectable.



This 250,000 B.Th.U. per hour oil-fired air heater incorporates two air projector units in which the hot air discharging through a vertical nozzle draws in cold air and mixes with it before discharging horizontally 8 or 9 ft. above floor level.

OIL-FIRED AIR HEATERS

Aluminised Mild-Steel Heat Exchanger

Two new industrial mobile oil-fired air heaters with capacities of 250,000 and 500,000 B.Th.U. per hour respectively, have been added to the range manufactured by A. E. Greaves and Son, Limited, 141 Elm Grove, Southsea, Hampshire. The new heaters are similar in principle to the 125,000 B.Th.U. per hour unit described in the February 11, 1955, issue of ENGINEERING (page 182); they burn finely atomised oil in a sealed heat exchanger over which air circulates at high speed. Both fan impeller and fuel pump are driven from a single electric motor.

Shown in the accompanying illustration is the 250,000 B.Th.U. per hour heater, which has two air projector units in the form of "injectors". The hot air is discharged through a vertical nozzle which is designed to draw in a quantity of cold air through the four holes which can be seen in the vertical part of the projector. The resulting mixture of hot and cold air is then discharged horizontally at a height of between 8 ft. and 9 ft. above floor level, the temperature of the discharged mixture being just sufficient to prevent it from descending to ground level too soon and, on the other hand, being not too high to cause it to rise straight to the roof. In this way it is possible to project the air for distances of over 100 ft.; this air is recirculated back into the fan inlet. It is possible to have the heaters installed actually inside a factory; and when in operation they cause the floor temperature to be appreciably higher than the roof temperature.

The heat exchanger consists of a central combustion chamber surrounded by an annulus through which the combustion gas returns to pass into the flue pipe. This heat exchanger fits into the casing on top of the fan, and air flows through a slot in the annulus around the combustion chamber and out through a slot at the top of the annulus. A proportion of the air to be heated also flows around the outside of the annulus.

The company state that they have had much better results using a mild-steel aluminium-sprayed heat exchanger than with plain stainless steel, and they have used heat exchangers at quite high temperatures for specialised applications, such as paint drying, without any adverse effects at all, although corresponding stainless-steel heat exchanger used in the same conditions showed signs of scaling after prolonged service.

* * *

GERMANIUM RECTIFIER FOR BRITISH RAILWAYS

A 750 kW air-cooled germanium rectifier, manufactured by British Thomson-Houston Company, Limited, Rugby, has recently undergone successful trials on a train running on the Lancaster-Morecambe-Heysham line in the London Midland Region of British Railways. The equipment is arranged for full-wave rectification.

* * *

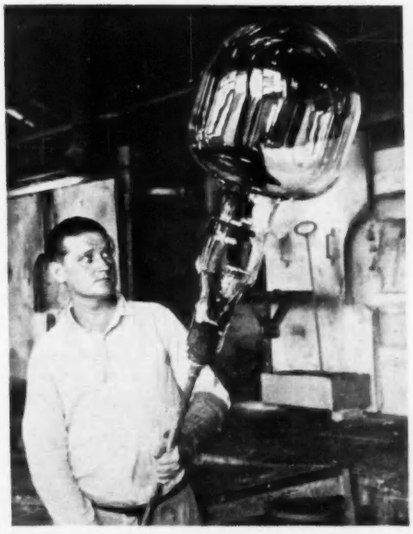
20 KW FILAMENT LAMP

Studio Lighting from Single Source

The largest tungsten-filament lamp made in this country—a 20 kW lamp—has been manufactured by the British Thomson-Houston Company at a research and development cost of over £10,000. Designed for film studio lighting, the new lamp will be used in making colour films.

The Mazda 2 and 5 kW lamps were developed before the war, but the 5 kW lamp, for example, had an effective life of only 25 hours. After the war the demand arose for increasingly powerful light sources and B.T.H., in collaboration with film studios, developed a series of lamps for colour photography with the ultimate object of keylighting a whole film studio set from one light source. A 10 kW lamp was successfully built, for which there has been a very large demand.

The B.T.H. Company's glass works at Chesterfield have now produced the 15 in. diameter boro-silicate bulb, shown below, for the new lamp. It is of uniform thickness to reduce the likelihood of breaking strains, and weighs 10 lb.; the filament contains sufficient tungsten to make 20,000 household 40 W. lamps. Its 50,000 mean spherical candle power is approximately 1,600 times that of a 40 W bulb. Production of lamps of 50 kW and 75 kW is envisaged by the company in the future.



A craftsman at the B.T.H. Chesterfield lamp works checks the glass bulb for the Mazda 20 kW lamp—the largest tungsten lamp made in Britain.

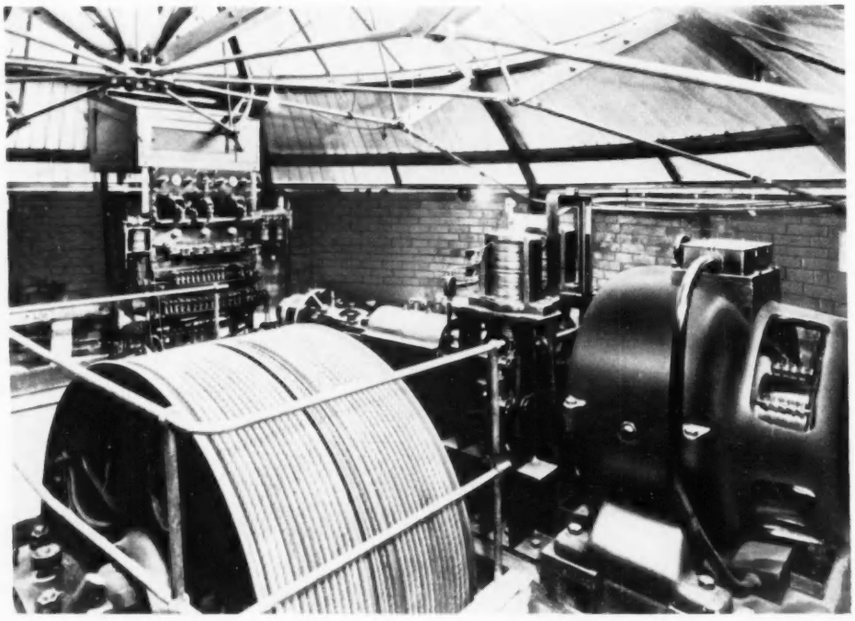


Fig. 1 The original lift drive installed by the Easton Lift Company, Limited, at the south end of Woolwich Tunnel, showing the camshaft controller which replaced the face-plate starter in 1932.

LIFT MODERNISATION AT THAMES TUNNELS

USE OF VARIABLE-VOLTAGE DRIVES

Access to the pedestrian tunnels under the Thames at Greenwich and Woolwich (which were opened in 1903 and 1912 respectively) is obtained by lifts, the equipment of which, with the exception of the controllers, has been in service during the whole period of operation. It has now, however, been replaced by new machinery supplied by the Express Lift Company, Limited, Greycoat-street, London, S.W.1, whose predecessors, the Easton Lift Company, Limited, were responsible for the original installation. An illustration of this drive at the south end of the Woolwich Tunnel, showing the camshaft controller, which was installed in 1932 to replace one of the face-plate type, appears in Fig. 1.

The new equipment at Greenwich, which began operation in December, consists of Ward Leonard variable voltage sets made up of an 80 h.p. three-phase motor driving a 52 kW compound generator running at 1,460 r.p.m. Similar sets are installed at Woolwich, although their outputs are only 35 kW. All the motor-generators are mounted on concrete blocks with cork-pad sound insulation.

BRAKING EQUIPMENT

The lifts are operated by 60 h.p. 230 volt enclosed ventilated motors at Greenwich, as shown in Fig. 2, and 40 h.p. 230 volt motors at Woolwich, the drive being taken through 57 to 1 worm gearing and a 39 in. sheave, which is connected to the worm wheel by a fabricated spider. To reduce wear the diameters of the worm wheels and sheaves have been made as nearly equal as possible. The sheaves have pre-formed grooves to accommodate $\frac{7}{8}$ in. diameter driving ropes, of which there are eight on each lift at Woolwich and six at Greenwich. Diverter pulleys, 39 in. in diameter, are provided to obtain the required suspension centres between the cars and the counterweights. Epicyclic hand winding gear is provided for emergency use. When this is fitted to the worm-shaft all the electrical circuits are broken automatically and cannot be restored until the winding gear has been removed.

Braking is effected by self-aligning shoes which operate on a drum between the motor and the worm shaft. The brakes are applied by springs and are released electromagnetically. The original car guides at Greenwich have been replaced by others machined from 85 lb. rail sections, while 50 lb. sections are now used for the counterweight guides. Conventional machined T-section guides are employed at Woolwich. The original cars are still in use, as are the governor-controlled safety gears. The car and landing gates have been renewed, new locks with pre-locking contacts being provided on the latter.

Fig. 2 The new variable-voltage equipment installed by the Express Lift Company, Limited, for the lift at the north end of Greenwich Tunnel.

CONTROL ARRANGEMENTS

The motor-generators are started by line and accelerating contactors, the latter short-circuiting a stator resistance when the sets approach full speed. The main control equipment consists of further contactors, relays, protective devices, and resistors as well as a three-phase transformer and rectifier, from which direct-current at 100 volts is supplied to the control equipment, to the brakes and to the generator and lift motor fields. A view of the two cubicles at the north end of Greenwich Tunnel, in which all this equipment is installed, is given in Fig. 3.

While the lifts are still operated by attendants, "up" and "down" push buttons have replaced the original drum controllers. The cars also contain key-operated switches for the lighting, for the remote control of the motor-generators and for disconnecting the control circuits. When an "up" or "down" push button is pressed the hoisting motor field is excited to full strength, the generator armature circuit is closed and the generator shunt field is excited with the polarity necessary to drive the motor in the required direction. At the same time the brake lifts and the hoist motor starts.

Acceleration is effected by increasing the generator shunt field current by closing three time-controlled contactors, top speed being finally attained by weakening the hoisting motor shunt field. As the car approaches the landings limit switches close so that the motor shunt field is strengthened and the generator shunt field is weakened in two steps. Final levelling speed is attained and the car stopped by magnetic inductor switches, which are installed in the car and are operated by steel plates in the shaft. On passing the first of these plates the shunt field is reduced to its minimum value and the car moves at levelling speed. On passing the second plate the generator shunt field is disconnected, the differential field is brought into circuit and the brake is applied to stop the car at floor level. At the same time the hoisting motor shunt field is reduced to its standing value and after about a second a contactor opens and isolates the hoisting motor armature from the generator.

Control is also exercised by a diverter across the series winding of the generator so that the compounding is varied for top speed and levelling. The resulting regeneration allows deceleration to be effected in a minimum time and ensures a virtually constant final speed, so that the car stops accurately at floor level irrespective of the load.

HIGH RATES OF ACCELERATION

The employment of the Ward Leonard system in the way described enables higher rates of acceleration and deceleration to be employed,

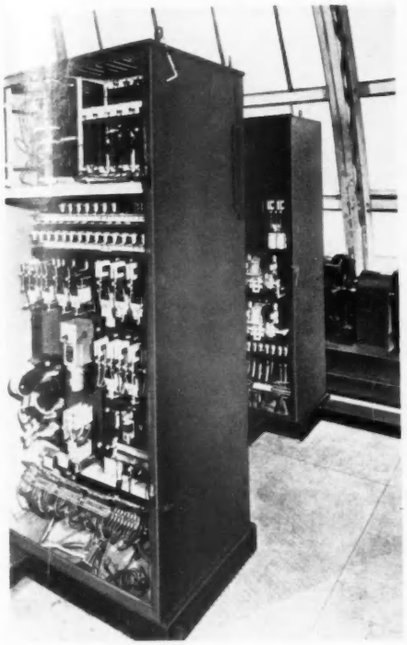


Fig. 3 Control and starter cubicles at the north end of Greenwich Tunnel.

while the resulting rise in average speed has increased the passenger handling capacity. Moreover, as control is now effected by varying relatively small currents in the generator shunt field the new switchgear is lighter and its wearing parts smaller. A further improvement is the installation of a "mechanic control station" on the top of the cars. This comprises "up" and "down" pushes, a test switch, emergency switch and socket outlet. The test switch brings the "up" and "down" pushes into circuit and disconnects the normal car control, while the emergency switch provides overall protection and the socket outlet allows an inspection lamp or portable tool to be used. The car will only travel in the appropriate direction as long as pressure is maintained on the push buttons, while a limit switch stops it about 3 ft. below top level to prevent personnel coming into contact with the overhead steel work.

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LAUNCHES AND TRIAL TRIPS

M.S. "SHELL STEELMAKER."—Single-screw oil tanker, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for Shell-Mex and B.P., Ltd., London, W.C.2. Main dimensions: 139 ft. overall by 21 ft. 6 in. by 12 ft.; deadweight capacity, 460 tons on a draught of 10 ft. 6 in. Lister-Blackstone six-cylinder four-stroke Diesel engine, with a modern wheel drive oil-operated clutch, developing 360 b.h.p. at 600 r.p.m. Engine constructed by R. A. Lister & Co., Ltd., Dursley, Glos. Launch, December 6.

M.S. "COOLAROO."—Single-screw refrigerated-cargo vessel, with accommodation for twelve passengers, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for the Rederiaktiebolaget Transmark, Gothenburg. Main dimensions: 400 ft. between perpendiculars by 54 ft. by 27 ft. 10 in. to main deck; deadweight capacity, about 5,650 tons on a draught of 25 ft.; cargo-carrying capacity, 240,000 cub. ft. bales. Eriksbergs-B. and W. six-cylinder single-acting two-stroke Diesel engine, developing 6,500 b.h.p. Speed, 18 knots when carrying a fruit cargo of 3,000 tons deadweight on a draught of about 20 ft. 3 in. Launch, December 12.

S.S. "ESSO PRESTON."—Single-screw vessel for the carriage of hot bitumen or other petroleum products in bulk. Built and engined by Hall, Russell & Co., Ltd., Aberdeen, for the Esso Petroleum Co., Ltd., London, S.W.1. Main dimensions: 485 ft. overall by 42 ft. by 20 ft. 9 in.; deadweight capacity, about 2,300 tons. Triple-expansion steam reciprocating engine developing 1,300 i.h.p. Steam provided by two oil-fired Scotch marine boilers. Launch, December 14.

M.S. "KYOTO."—Single-screw cargo vessel, with accommodation for a small number of passengers, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, to the order of the Swedish Eastasiatic Co., Gothenburg. Last of a series of three vessels for these owners. Main dimensions: 445 ft. between perpendiculars by 62 ft. by 38 ft. 6 in. to shelter deck; deadweight capacity, 8,400 tons with shelter deck open and 9,200 tons with shelter deck closed; draught when fully loaded, about 25 ft. 9¼ in.; cargo-carrying capacity, 538,700 cub. ft. bales (including 38,000 cub. ft. refrigerated space.) Eriskbergs-B. and W. seven-cylinder single-acting two-stroke Diesel engine developing 8,300 b.h.p. and arranged for running on heavy oil. Service speed, 17 knots fully loaded. Delivered, December 15.

S.S. "RUTH LAKE."—Single-screw vessel for the carriage of iron ore and oil cargoes, built by Swan, Hunter, and Wigham Richardson, Ltd., Wallsend-on-Tyne, for the Iron Ore Transport Co., Ltd., of Canada. Main dimensions: 630 ft. between perpendiculars by 87 ft. by 45 ft. 6 in. to upper deck; deadweight capacity, about 31,000 long tons on a draught of 34 ft. Double-reduction geared steam-turbines developing 12,500 s.h.p. at 105 r.p.m. in service, and two Foster Wheeler "D" type water-tube boilers arranged for burning oil only. Turbines and boilers constructed by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Service speed, 14¾ knots. Launch, December 15.

S.S. "SAMUEL UGELSTAD."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for S. Ugelstads Rederi A/S. Oslo, Norway. Main dimensions: 661 ft. 7 in. overall by 87 ft. by 45 ft. 6 in.; deadweight capacity, about 32,000 tons on a summer draught of 34 ft. 2 in.; oil-tank capacity, about 31,140 tons. Double-reduction geared steam turbines, developing 12,500 s.h.p. at 105 r.p.m. in service, constructed by Richardsons, Westgarth & Co., Ltd., Wallsend-on-Tyne. Steam supplied by two Foster Wheeler "D" type boilers. Speed in service, 15½ knots. Launch, December 15.

M.S. "OTI."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for Elder Dempster Lines, Ltd., Liverpool. Main dimensions: 425 ft. between perpendiculars by 62 ft. by 34 ft. to shelter deck; gross tonnage, about 5,900. Harland-B. and W. five-cylinder single-acting two-stroke opposed-piston Diesel engine. Launch, December 15.

M.S. "DONA MARGARITA."—Single-screw dry cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Compania Panamena Europea Navegacion Limitada, Panama (Agents: Chandris (England), Ltd., London, E.C.3.). Second vessel of an order of four for these owners. Main dimensions: 450 ft. between perpendiculars by 62 ft. by 39 ft. 6 in. to upper deck. As open-shelter-deck ships, these vessels have a deadweight capacity of about 10,880 tons on a draught of 26 ft. 8¾ in., but, when in use with closed shelter decks, they have a deadweight of about 12,660 tons on a draught of 29 ft. 4 in. Doxford four-cylinder opposed-piston oil engine of 4,800 b.h.p., to give a speed of 13¾ knots at 112 r.p.m. in fair weather. Launch, December 15.

BOEING "INTER-CONTINENTAL" AIR-LINER

More Payload, More Range

A larger and longer-range air-liner than the Boeing 707 Stratoliner is to be developed by the Boeing Airplane Company, Seattle, Washington, U.S.A. Known as the Intercontinental, the new air-liner, at an all-up weight of 290,000 lb., will have a seating capacity for 124/145 passengers and a range of more than 4,000 miles with full payload and fuel reserves. A cruising speed of 575 m.p.h. is forecast. It will be powered by four Pratt & Whitney JT4 turbojets. The overall length of the Intercontinental is 146 ft. 8 in., that is, 12 ft. 2 in. longer than the Stratoliner, and the wing span is to be 141 ft. 6 in. —10 ft. 8 in. longer. The payload, 36,500 lb., is 8,500 lb. more than that of the Stratoliner, and the fuel capacity is increased by 3,800 gallons to 21,200 U.S. gallons. The wing area is increased by 20 per cent., which, it is claimed, will make possible the utilisation of shorter runways for takeoff and landing.

Pan American Airways have ordered 12 Intercontinentals, which will be substituted for a portion of their original order for Stratoliners. Air France have ordered ten, and Sabena three. The first of the Intercontinentals is planned for delivery in August, 1959, eight months after the first of the Stratoliners.

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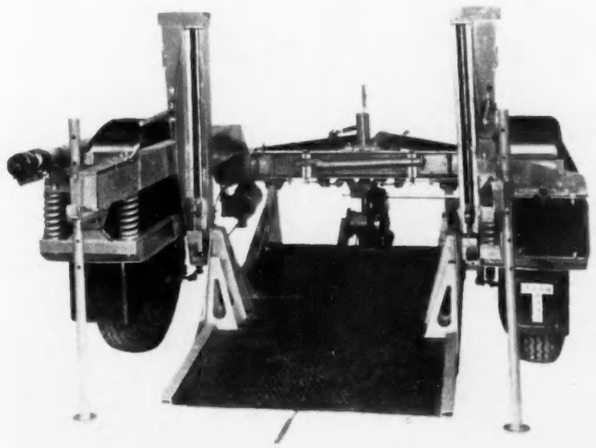
FOUR-TON DUAL-PURPOSE TRAILER

The accompanying illustration shows a four-ton trailer of special design, which has recently been supplied by Messrs. Richard C. Gibbins and Company, Limited, Berkley-street, Birmingham, 1, to one of the Area Electricity Boards. As will be seen it consists essentially of one of the firm's tractors for carrying cable drums which has been adopted to transport transformers by slinging a detachable platform between the drum bearers, an operation which can be effected in a few minutes.

For this purpose the front end of the platform is supported on pin joints which are anchored to the underside of the front cross member of the trailer chassis. When the cable drum jacks are screwed down this platform tilts to form a ramp up which the load is drawn by a hand-operated winch in the front of the trailer. Once the load is on board the platform is raised by the jacks to its normal position.

Such a dual-purpose trailer should, it is considered, be useful to both Area Electricity Boards and cable laying contractors, since it enables two self-loading transporters to be combined into one with consequential economies in both first and operating costs.



Four-ton dual-purpose trailer for transporting cable drums and transformers.

Fig. 1 In general, gearbox production follows a four-week cycle of different types. In all, 60 variations of 16 different types are made as standard units, but there is also accommodation for the production of various special items.

GEARBOX PRODUCTION INCREASED

ASSEMBLY IN ROTATION

After the Whitsun holiday in 1955, the first units of the new machine shop of the automobile gearbox division of David Brown & Sons (Huddersfield) Limited, began operation. As other parts of the building were completed the assembly and fitting sections moved in. In the new premises 60 variations of 16 basic gearbox models are in production; those being built can be divided roughly into two main categories, for light commercial vehicles and for heavy transport. In addition the division supplies all the gearboxes for the Aston Martin and Lagonda cars. Manufacture is divided into two distinct sections, the cases and the components. Part of the assembly lines is shown in Fig. 1.

Incoming materials in the form of castings and bar stock are delivered to a section of the basement which forms the stores, while stampings and forgings are kept in the open stock yard. At the opposite end of the basement are stored special jigs of which one set is held for every type of gearbox in production.

MACHINING THE CASES

One of the essentials of gearbox manufacture is that the case shall be accurate and rigid. To obtain this the question of size and weight must be balanced with oil capacity, durability and strength. Consequently, aluminium is used in the majority of cases. This has secondary effects in that it is light enough to be moved by the operators, and mechanical handling equipment can therefore be reduced to a minimum; also, being comparatively soft, high rates of cutting feeds and speeds are permissible.

After inspection, casings of the splitcase type are milled on the joint faces as top and bottom halves. When the bolt holes have been drilled, the two halves are bolted together and the end faces milled on a double-headed duplex machine. The seatings for the shaft bearings are then bored, using piloted boring bars, and in some instances one or two inner walls as well.

Milling and drilling of the power take-off selector rod and other faces, such as draining plugs and dipstick holes, follow. The cases are then examined and stored, the inside faces being given a coat of oil-resistant paint; one-piece casings follow the same general machining procedure.

Bell housings for gearboxes in the larger range have the engine facing register diameter machined to within 0·020 in. The finishing skim is carried out as a final operation, so that any distortion incurred during handling will be rectified.

GEARS AND SHAFTS

Gears and shafts are usually machined from controlled grain size stampings in the normalised and annealed condition. The shafts are machined on copy-turning lathes, and the gear blanks and housings are turned complete on chucking auto-lathes. Bored gears are broached, and then the gear faces skimmed on mandrels to ensure their concentricity. Internal and external clutch teeth are cut on shaping machines, whilst all other gears have their teeth cut on David Brown hobbers. A Hydrax high-speed hobber, built and supplied by David Brown Machine Tools Limited, was installed when the division moved into the new premises. Tooth rounding, dressing and shaving follows, then after rigorous inspection those components requiring hardening pass to the heat-treatment station. The latter has been designed to cope with a flow of work which is repetitive in nature but consists of a wide variety of parts in relatively small batch quantities.

Gas carburising is performed in a horizontal radiant tube furnace. All the work is handled on horizontal conveyors and is quenched on ram-operated tables in oil tanks set immediately under the furnace doors. Parts made in quantities too small to handle in a large plant are separately treated by case or surface hardening. There is also a high-frequency plant for local softening and tempering. Components then receive low-temperature tempering and are shot-blasted, after which inspection again follows and they pass for final machining operations.

Finished cases and finished components are kept in separate stores from which they are issued to the assembly lines as required. Here again a flow pattern is followed but the arrangement does not permit a straight line as in the machine shops, and the items are passed from bench to bench finishing at the test section which is adjacent to the finished-component stores. The fully-tested boxes are transfered to the loading dock in the basement of the building for dispatch to their various destinations.

All those items which are not included in the gears or casings, such as speedometer drives and synchromesh mechanisms, are made separately as required and a rigid flow line cannot be laid down for them.

FOUR-WEEK CYCLE

When the gearbox section was established as a separate division, it was decided that certain types of gearboxes were to be passed through assembly on a cycle basis, each cycle covering a four-week period, but this is not applied as a rigid rule. In addition, a certain amount of sub-assembly work is done on some types, and shafts fitted with gears are kept in store. These two arrangements have helped to bring about a considerable increase in production, but have still left room for individual attention to special and urgent demands.

After assembly the gearboxes are filled with oil and run in, one gear at a time, on a motor-driven dynamometer test plant running under light load. Ease of engagement is also checked at this stage. Two sound-insulated test cubicles adjoin the loading dock in the basement, and in these the gearboxes are run under actual torque conditions. One of these is shown in the Fig. 2 below. A six-cylinder Diesel engine drives the plant which is used to test the heavy commercial vehicle and passenger vehicle boxes. The operator controls running speeds and gear changes by accelerator and clutch and can also apply a varying load.

The Aston Martin and Lagonda gearboxes are tested on a smaller plant driven by a four-cylinder petrol engine. These units run for 8 hours at maximum speed, after which all parts are inspected and crack detected before being finally approved.

It is more than 40 years since the first automobile gearbox was made at the Park Gear Works, and the present division was formed in 1951; between then and 1953, production rose in volume by 50 per cent. while the labour force decreased by nearly 10 per cent. By the beginning of 1954, it became evident that additional plant would be necessary if delivery periods were not to lengthen considerably, and the new buildings were therefore constructed beside the parent company's works. The floor area of these buildings is 44,000 sq. ft. and in addition to the machine shop and assembly area there is included an administrative block which houses a drawing office, drawing stores and general offices. This is built on one side of the main block.

Fig. 2 In two sound-insulated chambers, one of which is illustrated, gearboxes can be tested under load conditions. The operator has full control of both speed and torque applied.

HONOURS LIST

Many engineers, industrialists and scientists are among those whose names are contained in the New Year Honours List, published on January 2. Included among them are those mentioned below.

Baron

Sir Frederick Godber, chairman, Shell Transport and Trading Co., Ltd.

Baronet

Sir Hubert Stanley Houldsworth, D.Sc., Q.C., chairman, National Coal Board.

Knights Bachelor

Eric Ashby, D.Sc., President and Vice-Chancellor of Queen's University, Belfast; Charles Connell, chairman, Connell & Co., Ltd., Glasgow; Lieut.-Colonel Leslie E. Ford, O.B.E., R.E. (T.A.), general manager, Port of London, London; Brigadier Alexander H. Killick, C.B.E., D.S.O., secretary, Royal Institution of Chartered Surveyors; William Lyons, chairman and managing director, Jaguar Cars, Ltd., Coventry; George M. McNaughton, C.B., M.I.C.E., M.I.Mech.E., chief engineer, Ministry of Housing and Local Government; Alfred G. Pugsley, O.B.E., D.Sc., F.R.S., Professor of Civil Engineering, University of Bristol; and Professor Solly Zuckerman, C.B., deputy chairman, Advisory Council on Scientific Policy.

Order of the Bath

G.C.B. Sir Harold Corti Emmerson, K.C.B., K.C.V.O., Permanent Secretary, Ministry of Works, and Permanent Secretary designate, Ministry of Labour and National Service.

K.C.B. Sir Frederick Brundrett, K.B.E., C.B., chairman, Defence Research Policy Committee and scientific adviser to the Minister of Defence.

C.B. Dr. Walter Cawood, C.B.E., B.Sc., principal director of scientific research (air), Ministry of Supply; William C. M. Couch, C.B.E., M.I.E.E., deputy director of electrical engineering, Admiralty; Air Commodore William E. G. Mann, C.B.E., D.F.C., M.I.E.E., director general of navigational services (civil aviation), Ministry of Transport and Civil Aviation; William J. Richards, C.B.E., B.Sc., director, Radar Research Establishment, Ministry of Supply; and Major-General John C. T. Willis, C.B.E., late Corps of Royal Engineers.

Order of St. Michael and St. George

C.M.G. Charles T. F. Serjeant, B.Sc.(Eng.), A.M.I.C.E., formerly deputy general manager, Sudan Railways; E. E. Warren, for services to the coal industry in Australia; O. H. Woodward, for services to mining and metallurgy in Australia; and Edgar R. Wilkinson, commercial manager, Central Electricity Authority.

Order of the British Empire

G.B.E. Sir John Morison, chairman, Iron and Steel Holding and Realisation Agency since 1953.

D.B.E. Mrs. Kathleen Lonsdale, D.Sc., F.R.S., Professor of Chemistry and head of the department of Crystallography, University College, University of London.

K.B.E. Sir Hugh E. C. Beaver, M.I.C.E., M.I.Chem.E., for public services and services to industry; Sir Claude D. Gibb, C.B.E., D.Sc., F.R.S., chairman, C. A. Parsons & Co., Ltd., Newcastle-upon-Tyne; and the Honourable Malcolm McIntosh, Minister of Works and Minister of Marine, State of South Australia.

C.B.E. Cecil E. H. Bawn, Ph.D., F.R.S., Grant-Brunner Professor of Inorganic and Physical Chemistry, University of Liverpool; Captain Charles F. Booth, O.B.E., M.I.E.E., assistant engineer-in-chief, General Post Office; William H. Cashmore, Director, National Institute of Agricultural Engineering, Silsoe, Bedfordshire; Samuel H. Clarke, M.Sc., Director, Fire Research Station, Department of Scientific and Industrial Research; Harold V. Disney, chief engineer, Industrial Group Headquarters, United Kingdom Atomic Energy Authority, Risley; Arthur T. Doodson, Director, Liverpool Observatory and Tidal Institute; Douglas C. Fairbairn, C.I.E., Secretary of the Bengal Chamber of Commerce and Industry, and the Associated Chambers of Commerce of India, since 1938; Archibald G. Glenister, chairman, Malayan Chamber of Mines; Robert Graham, M.I.Mech.E., F.R.Ae.S., director of aircraft research and development, Ministry of Supply; Leslie D. Harkess, director, contracts department, General Post Office; Herbert V. Hayes, director, air technical publications, Ministry of Supply; Harold F. Hodgson, managing director, Joseph Sankey and Sons, Ltd., Bilston, Staffordshire; John Hudson-Davies, formerly director of the Posts and Telegraphs Department, Sudan Government; Captain William Hutchison, chief marine superintendent, British Aviation Co. Ltd.; Percy E. R. Jeffries, F.R.I.C.S., chief surveyor, Admiralty; John C. Lithgow, M.I.E.E., for services to the Uganda Electricity Board; Christopher Macrae, secretary, The Scottish Council (Development and Industry); Rennie J. Moffat, M.B.E., director-general of marketing, National Coal Board; Thomas Paris, Assistant Secretary, air services "A" division, Ministry of Transport and Civil Aviation; Harry Richardson, M.Sc., F.Inst.P., Principal, Bradford Technical College; Thomas A. Rogers, M.I.Min.E., deputy chief inspector of mines and quarries, Ministry of Fuel and Power; Reginald S. Stafford, technical director, Handley Page, Ltd., London, N.W.2; Gerald Steel, J.P., general managing director, United Steel Companies, Ltd., Sheffield; Edwin P. Stewart, F.R.I.C.S., chief surveyor, Air Ministry; George V. Strudwick, director of contracts, Ministry of Works; and James G. Taylor, M.I.C.E., divisional road engineer, North Eastern Division, Ministry of Transport and Civil Aviation.

O.B.E. George C. W. Baldwin, executive engineer, Public Works Department, Northern Rhodesia; John J. Bryan, chief engineer, Singapore Airport; Joseph L. Burchnall, M.C., M.A., Professor of Mathematics, University of Durham; John T. Byrne, M.B.E., J.P., area secretary, West of Scotland, Electrical Trades Union; Walter S. Catlow, A.M.I.C.E., senior civil engineer, War Office; Leslie Cocollis, M.B.E., managing director, British Overseas Boat Co., Ltd.; Thomas H. Corkill, chief engineer, s.s. Forester, Thos. and Jas. Harrison, Ltd., Liverpool; Frederick J. Cowlin, M.I.Mech.E., chief engineer, steam turbine division, English Electric Co., Ltd., Rugby; Robert McC. Douglas, chairman and managing director, Robert M. Douglas (Contractors), Ltd., Erdington, Birmingham; Henry J. Dowden, M.C., B.A., senior principal scientific officer, Department of Scientific and Industrial Research; Douglas G. Duff, lubricating oil adviser, Ministry of Fuel and Power; Frank Elliott, formerly chief Government mining engineer, Southern Rhodesia; Lieut.-Colonel Gwilym T. Evans, technical adviser, War Office (seconded from the General Post Office); Fred Greenwell, secretary, British Coking Industry Association; Alan J. A. Hanhart, solicitor and assistant general manager, Royal Automobile Club; Lieut.-Colonel Derrick Heald, R.E., assistant director, Ordnance Survey Department, Southampton; Frederick Heap, chairman, Association of Steel Drum Manufacturers; Arthur A. Howgrave, principal inspection officer, packaging, Inspectorate of Electrical and Mechanical Equipment, Ministry of Supply; Willliam J. Huggett, manager, marine department (carrier equipment), General Electric Co., Ltd., Fraser and Chalmers Engineering Works, Erith, Kent; Ronald F. Johnston, principal scientific officer, Atomic Weapons Research Establishment, United Kingdom Atomic Energy Authority, Foulness; James Johnstone, J.P., regional industrial relations officer, Ministry of Labour and National Service; Thomas H. Kernohan, secretary, Engineering and Allied Employers' (Northern Ireland) Association; George MacAulay, controller of transport, Ministry of Works; Frank J. McIntosh, chief engineer of the Rhodesia Railways at Bulawayo, Federation of Rhodesia and Nyasaland; James K. McKendrick, general manager and secretary, Tyne Improvement Commission; Cecil C. Morley, A.F.C., chief engineer, Maintenance Command, Royal Air Force; John D. Morton, M.A., senior principal scientific officer, Ministry of Supply; Charles W. Oatley, M.A., M.Sc., M.I.E.E., Reader in Engineering, University of Cambridge; Herbert Parrish, A.M.I.Mech.E., chief engineer, Henry Wiggin & Co., Ltd., Birmingham; Francis H. Perkins, education officer, Imperial Chemical Industries, Ltd.; Harry J. Perrins, M.I.Min.E., senior district inspector of mines and quarries, Durham Division, Ministry of Fuel and Power; Sydney F. Prentis, formerly chief executive officer, Royal Aircraft Establishment, Ministry of Supply, Farnborough; John D. S. Rawlinson, B.Sc., M.I.E.E., senior principal scientific officer, Admiralty; Miss Esther Simpson, assistant secretary, Society for Visiting Scientists; Reginald S. Snelling, deputy chairman, Wales Gas Board; Gordon Thripp, deputy principal, Indian Air Force Technical Training College, Jalahalli, India; Roland V. Trace, director of public works, Electricity and Land Survey, Zanzibar; Geoffrey A. V. Tyson, chief test pilot, Saunders-Roe, Ltd., Cowes, Isle of Wight; Raymond C. Warren, M.B.E., principal inspector of accidents, Accidents Investigation Branch (Civil Aviation), Ministry of Transport and Civil Aviation; William E. Watts, superintending examiner, Patent Office, Board of Trade; and Harold Weston, M.I.E.E., generation engineer, Belfast Corporation Electricity Department.

M.B.E. Donald A. Alves, A.M.I.C.E., the bridge engineer, Somerset County Council; Alfred J. A. Armstrong, engineer technical, grade 1, Royal Aircraft Establishment, Ministry of Supply; Kenneth H. Beale, dry dock manager, Smith's Dock Co., Ltd., South Bank, Yorkshire; Frank Bingley, Dallow Lambert & Co., Ltd., Leicester; Uriah J. Bloomer, inspector of works, Public Works Department, Federation of Nigeria; Arthur Bowen, mechanical engineer, British Thomson-Houston Co., Ltd., Rugby; Raymond C. Butters, chief machine progress superintendent, English Electric Co., Ltd., Stafford; Frederick A. Crouch, inspector, Aeronautical Inspection Directorate, Ministry of Supply; John S. Curphey, steel plant manager, Dorman Long (Steel), Ltd., Middlesbrough; Charles C. Davies, electrical engineer, Admiralty; Godfrey E. Drewett, divisional superintendent, Westinghouse Brake and Signal Co., Ltd., Chippenham; Paul E. Evangelides, senior technical assistant, Public Works Department, Cyprus; Arthur F. Farnfield, county engineer, Afikpo County and District Council, Eastern Region, Nigeria; Horace W. Featherstone, senior executive officer, London Region, Ministry of Fuel and Power; Arthur A. Fisher, senior executive engineer, Public Works Department, Federation of Malaya; Edwin T. Grattidge, chief engineer, John M. Henderson & Co., Ltd., Aberdeen; Ephraim Greenwood, mechanical inspector, Public Works Department, Hong Kong; Sydney H. Groom, senior research assistant (guide lecturer), Science Museum; George Gunn, A.M.I.E.E., generation engineer (operation), South of Scotland Electricity Board; Richard H. Harral, sub-area manager, North Western Electricity Board; William E. Harris, D.S.C., engineer II, Atomic Energy Research Establishment, Harwell; Robert Haworth, chief draughtsman, Santon, Ltd., Newport, Monmouthshire; Norman Hewgill, works assistant, East African Railways and Harbour Administration; Edward G. Hittersay, resident engineer, Mountain Road, Basutoland; Roland G. Hodges, senior experimental officer, Radar Research Establishment, Ministry of Supply; Robert F. Holliday, area engineer, London Telecommunications Region, General Post Office; Arthur Ibbotson, chief draughtsman, plant department, Metropolitan-Vickers Electrical Co., Ltd., Manchester; Francis N. Judson, industrial sales manager, Mobil Oil Co., Ltd.; Alfred S. Keeling, development engineer in the Iraqi Directorate-General of Posts and Telegraphs, Baghdad; James A. Kermode, chief engineer, s.s. Maipura, Thos. and Jno. Brocklebank, Ltd., Liverpool; Edgar L. Killip, A.F.C., operations research and planning manager, British European Airways; William T. Marsh, area planning and progressing manager, North Eastern Division, National Coal Board; William S. Martin, chief inspector, Brown Brothers (Aircraft), Ltd., Northampton; Adam H. Menzies, chief engineer, Jute Industries, Ltd.; Charles J. Miles, marine engineer, British Transport Commission; Terence C. B. Miller, A.M.I.Mech.E., assistant motive power superintendent, Eastern Region, British Railways; Frank Morris, senior experimental officer, Ministry of Supply; Mrs. Florence E. Morrison, personal assistant to the secretary, Royal Aeronautical Society; Sydney H. C. Mound, chief motion study officer, Army Operation Research Group, War Office; John C. B. Redfearn, civil hydrographic officer, Admiralty; John Hunter-Rioch, general manager, Cambridge Division, Eastern Gas Board; Douglas C. Rogers, section head, Standard Telephones and Cables, Ltd., Ilminster, Somerset; William R. Rose, chief mechanical designer, General Electric Co., Ltd., Telephone Works, Coventry; Arthur J. Rowan, Principal, Technical Institute, Aden; James Scanlon, Principal, Thika Technical and Trades School, Kenya; Walter M. Searle, superintending inspector, Aeronautical Inspection Service, Royal Air Force, Hartlebury; Edgar W. Selby, engineer, Mechanical Engineering Department, Office of the Crown Agents for Oversea Governments and Administrations; Joseph W. Simmons, principal artificer, National Physical Laboratory; Foxwell B. D. Spencer, chief inspector, Public Works Department, Western Region, Nigeria; Frederick J. Stubbs, superintendent of works, Ministry of Works; Charles W. Whaler, assistant chief engineer, Northern General Transport Co., Ltd.; Charles E. White, assistant general manager (production), Brooke Marine, Ltd., Lowestoft; Horace C. Williams, formerly fitting shops manager, the Bristol Aeroplane Co., Ltd., Bristol; and John G. P. Zierold, technical manager, Briggs Motor Bodies, Ltd., Dagenham, Essex.

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PERMANENT EXHIBITION OF INSTRUMENTS

A permanent exhibition by member firms is to be opened by the Scientific Instrument Manufacturers' Association at their headquarters at 20 Queen Anne-street, London, W.1, on February 9, 1956. This decision follows the recent taking over by SIMA of the entire building, necessitated by the rapid growth of the instrument industry.

NOTICES OF MEETINGS

Aslib

LONDON
"The Documentation of History by Film," by Sir Arthur Elton, Bt. Previously advertised for Thurs., Jan. 12, 6 p.m., has now been CANCELLED.

British Institution of Radio Engineers

EDINBURGH
Open Meeting. Scottish Section. Department of Natural Philosophy, The University, Edinburgh. Fri., Jan. 13, 7 p.m.
GLASGOW
"Peaceful Uses of Atomic Energy," by Dr. K. G. McNeill. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Jan. 12, 7 p.m.
WOLVERHAMPTON
"Computer Control of Machine Tools," by H. Ogden. West Midlands Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., Jan. 11, 7.15 p.m.

British Interplanetary Society

BIRMINGHAM
"Space Ship Instrumentation," by R. A. Waldron. Midlands Branch. Regent House, St. Phillips-place, Colmore-row, Birmingham, 3. Sat., Jan. 14, 6.30 p.m.
YORK
Various short papers. Yorkshire Branch. Rectabite Hall, Clifford-street, York. Thurs., Jan. 12, 7.30 p.m.

British Welding Research Association

LONDON
Symposium on "Increasing Productivity by the Use of Welding." Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Thurs. and Fri., Jan. 12 and 13, 9.30 a.m. and 2.30 p.m.

Chemical Engineering Group

LONDON
"Explosions and Poisons: A Comparison of American and British Precautions," by J. H. F. Smith. Geological Society, Burlington House, Piccadilly, W.1. Tues., Jan. 10, 5.30 p.m.

Chemical Society

PORTSMOUTH
"Qualitative Analysis: New Techniques and Old Problems," by H. Holness. Southampton Branch. College of Technology, Anglesea-road, Portsmouth. Thurs., Jan. 12, 7 p.m.

Diesel Engineers and Users Association

LONDON
"Fundamentals of Free Piston Engines and Their Applications," by Evelyn S. L. Beale and Patrick Watson. Caxton Hall, Victoria-street, S.W.1. Thurs., Jan. 19, 2.30 p.m.

Illuminating Engineering Society

LONDON
"Recent Developments in Photometry and Colorimetry," by G. T. Winch. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., Jan. 10, 6 p.m.*
EDINBURGH
"The Lighting Engineer," by G. E. L. Comrie. Edinburgh Centre. 14 St. Andrews-street, Edinburgh 2. Wed., Jan. 11, 6.15 p.m.
HULL
"Street Lighting," by J. J. French. Leeds Centre. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Mon., Jan. 9, 7 p.m.
LIVERPOOL
"Lighting in Offices," by G. B. Lancaster. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., Jan. 17, 6 p.m.

Incorporated Plant Engineers

BRISTOL
Discussion on "Works Engineering Organisation." Western Branch. Grand Hotel, Bristol. Wed., Jan. 11, 7.15 p.m.
EDINBURGH
"Materials Handling," by J. Findlay. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Tues., Jan. 10, 7 p.m.
GLASGOW
"Some Factors Concerning Works Capital Expenditure," by F. Franklin. Glasgow Branch. Scottish Building Centre, 425-427 Sauchiehall-street, Glasgow. Thurs., Jan. 12, 7 p.m.
LEICESTER
Discussion on "Rust Prevention." Leicester Branch. Leicester College of Art and Technology, The Newarkes, Leicester. Wed., Jan. 11, 6.30 p.m.
LIVERPOOL
"Radiography in Industry," by E. J. Grimwade. Merseyside and North Wales Branch. Royal Institution, Colquitt-street, Liverpool. Thurs., Jan. 12, 7.15 p.m.
MANCHESTER
Discussion on "Power Factor Correction." Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., Jan. 10, 7.15 p.m.
NEWCASTLE-UPON-TYNE
"The Gas Turbine in Industry," by J. R. Needham. North East Branch. Roadway House, Oxford-street, Newcastle-upon-Tyne. Thurs., Jan. 12, 7 p.m.

Institute of British Foundrymen

BEDFORD
"Propeller Manufacture," by J. M. Langham. Bedford and Hertfordshire Section. At works of W. H. Allen, Sons & Co., Ltd., Bedford. Thurs., Jan. 12, 7.30 p.m.
BRISTOL
"Modern Cupola Practice," by W. H. Bamford. Bristol and West of England Branch. Grand Hotel, Bristol. Sat., Jan. 14, 3 p.m.
GLASGOW
"Jobbing Production of Light-Alloy Castings," by A. S. H. Sawers. Scottish Branch. Royal Technical College, Glasgow. Sat., Jan. 14, 3 p.m.
LINCOLN
"Foundry Developments," by D. Killingworth. Lincolnshire Branch. Technical College, Lincoln. Thurs., Jan. 12, 7.15 p.m.
MANCHESTER
"Practical Simple Costing in the Foundry," by G. Judd. Lancashire Branch. Midland Hotel, Manchester. Mon., Jan. 9, 7 p.m.
NEWCASTLE-UPON-TYNE
"Some Foundry Techniques," by C. R. van der Ben and H. Haynes. Newcastle Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Sat., Jan. 14, 6 p.m.
SHEFFIELD
"Dust Control in Foundries," by C. M. Stoch. Sheffield Branch. College of Technology, Pont-street, Sheffield. Mon., Jan. 9, 7.15 p.m.

Institute of Fuel

NEWCASTLE-UPON-TYNE
"Case Histories." Four papers sponsored by the National Industrial Fuel Efficiency Service. North Eastern Section. King's College, Newcastle-upon-Tyne. Mon., Jan. 9, 6.30 p.m.

Institute of Industrial Supervisors

GLASGOW
Annual General Meeting and Presidential Address. Glasgow Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Jan. 9, 7.30 p.m.
LEEDS
Annual General Meeting and Discussion. Leeds Section. Great Northern Hotel, Leeds. Thurs., Jan. 12, 7.30 p.m.

Institute of Petroleum

LONDON
"Petroleum Fuels for Domestic Heating and Lighting," by G. F. J. Murray and D. G. Tompkins. Wed., Jan. 11, 5.30 p.m.*

Institute of Road Transport Engineers

LONDON
"The Development of Passenger Road Transport in Sweden, Particularly in Stockholm," by Carl Hammarskjold. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Jan. 19, 6.30 p.m.

Institute of Welding

LONDON
"Tubular Steel Design," by R. G. Taylor. South London Branch. 2 Savoy-hill, W.C.2. Thurs., Jan. 12, 6.30 p.m.*
CHATHAM
"Through the Welding Arc," by W. K. B. Marshall. Medway Section. Sun Hotel, Chatham. Wed., Jan. 11, 7.45 p.m.*

Institution of Civil Engineers

LONDON
"Consolidation of Ballast," by I. G. White. Railway Engineering Division. Tues., Jan. 10, 5.30 p.m.*
"The Roofing of Cleadon Reservoir," by N. J. Ruffle and H. Tottenham. Structural and Building Division. Thurs., Jan 12, 5.30 p.m.*
BIRMINGHAM
"Prestressed Concrete as Applied to Building Frames," by Francis Walley and H. C. Adams. Midlands Association. James Watt Memorial Institute, Great Charles-street, Birmingham. Thurs., Jan. 12, 6 p.m.*
LIVERPOOL
"Developments in Prestressed Concrete," by S. C. C. Bate. North Western Association. Picton Hall, William Brown-street, Liverpool, 3. Wed., Jan. 11, 7.30 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "The Efficient Use of Technical Personnel," opened by Sir George H. Nelson, Bt. Mon., Jan. 9, 5.30 p.m.* Discussion on "Teaching Electrical Engineering to Mechanical Engineering Students," opened by H. E. Dance. Education Discussion Circle. Tues., Jan. 10, 6 p.m.*
"Pulse-Time-Modulation Terminals for Music Transmission over Radio Links," by R. F. Rous. Radio and Telecommunication Section. Wed., Jan. 11, 5.30 p.m.*
CHELMSFORD
"An Introduction to the Transistor," by A. V. Bryant. London Graduates' and Students' Section. Public Library, Chelmsford. Tues., Jan. 10, 7. p.m.
NEWCASTLE-UPON-TYNE
"A Criterion of Distribution Cost," by D. J. Bolton. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Jan. 9, 6.15 p.m.
NOTTINGHAM
"The Standardisation of Retail Electricity Tariffs," by A. O. Johnson and N. F. Marsh. East Midland Centre. College of Arts and Crafts, Nottingham. Tues., Jan. 10, 6.30 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Thrust and Journal Bearings with Film Lubrication," by A. F. Wilson. North East Branch. Northern Architectural Association, 6 Higham-place, Newcastle-upon-Tyne. Mon., Jan. 9, 7.15 p.m.

Institution of Engineering Inspection

LONDON
Discussion on "Testing Gear for Inspection of Services' Electronic Equipment." Royal Society of Arts, John Adam-street, W.C.2. Wed., Jan. 11, 6.45 p.m.

Institution of Engineers-in-Charge

LONDON
"Working Environment and Accident Prevention," by B. A. Inshaw. St. Bride Institute, Bride-lane, Fleet-street, E.C.4. Wed., Jan. 11, 6.30 p.m.*

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Cargo-Handling Appliances," by L. T. Morton. Tues., Jan. 10, 7.30 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Small-Pipe Forced-Circulation Central Heating," by L. S. A. Burke. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Jan. 11, 6 p.m.*
CARDIFF
"Thermal Insulation of Plant and Buildings," by P. E. Millington. South Western Branch. G.E.C. Building, Cardiff. Tues., Jan. 10, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Overdrives and Their Control," by S. H. Ashby. Automobile Division. Tues., Jan. 10, 5.30 p.m.* Discussion on "Will High-Pressure Super-Charging Maintain the Lead of Four-Stroke Diesel Engines Over Two-Stroke Diesel Engines?" Internal Combustion Engine Group. Thurs., Jan. 12, 6.45 p.m.*
"Water-Ring Self-Priming Pumps," by E. Crewdson. Fri., Jan. 13, 5.30 p.m.*
BEDFORD
"Hydraulic Transport of Solids," by R. C. Worster and Dr. D. F. Denny. Annual General Meeting. Eastern Branch. Dujon Restaurant, Bedford. Thurs., Jan. 12, 7.30 p.m.
LEICESTER
Thomas Hawksley Lecture on "The Properties of Matter at High Pressure." by Professor D. M. Newitt. East Midlands Branch. College of Technology, Leicester. Tues., Jan. 10, 6.30 p.m.

Institution of Production Engineers

LONDON
"Works Cost Accounting," by B. Gateshill. London Graduate Section. Wed., Jan. 11, 7.15 p.m.
IPSWICH
"Factory Electrical Layout," by C. A. Marriott; "A Special Tapping Machine," by L. A. Childs; and "Flaw Detection," by E. J. Cove. Eastern Counties Section. Diocesan Hall, Tower-street, Ipswich. Fri., Jan. 13, 7.30 p.m.
OXFORD
"Production by Electronics," by E. R. Davies. Oxford Section. Town Hall, Oxford. Tues., Jan. 10, 7.15 p.m.
SHEFFIELD
"Health in Industry," by Dr. B. P. R. Hartley. Sheffield Section. Grand Hotel, Sheffield. Mon., Jan. 9, 6.30 p.m.

Institution of Railway Signal Engineers

YORK
Open Meeting to be held jointly with the Permanent Way Institution. Railway Institute, York. Tues., Jan. 10, 5.30 p.m.*

Institution of Structural Engineers

LONDON
"The Application of an Electronic Digital Computer to Some Problems of Structural Analysis," by Dr. R. K. Livesley. Thurs., Jan. 12, 6.30 p.m.
LIVERPOOL
"Photoelasticity," by Professor W. J. Kearton. Lancashire and Cheshire Branch. The University, Liverpool. Tues., Jan. 10, 6.30 p.m.
MANCHESTER
"Space Frames and Skin Structures," by F. J. Samuely. Lancashire and Cheshire Branch. College of Technology, Manchester. Thurs., Jan. 12, 6.30 p.m.

Junior Institution of Engineers

LONDON
"High-Altitude Passenger Flying, with Special Reference to Air Treatment," by B. T. Turner. Fri., Jan. 13, 7 p.m.

Newcomen Society

LONDON
"The Continental Origins of the Man-Engine, and Its Development in Cornwall and the Isle of Man," by David H. Tew. Iron and Steel Institute, 4 Grosvenor-gardens, S.W.1. Wed., Jan. 11, 5.30 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Modern Manufacture of Steel Plate for Shipbuilding," by T. F. Pearson. Neville Hall, Newcastle-upon-Tyne. Fri., Jan. 13, 6.15 p.m.

Royal Aeronautical Society

LONDON
Presidential Address by N. E. Rowe. Royal Institution, Albemarle-street, W.1. Thurs., Jan. 12, 6 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Aslib (Association of Special Libraries and Information Bureaux), 4 Palace-gate, London, W.8. (WEStern 6321.)
British Institution of Radio Engineers, 9 Bedford-square London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1.
British Welding Research Association, 29 Park-crescent, London, W.1. (LANgham 7485.)
Chemical Engineering Group, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Diesel Engineers and Users Association, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham 4. Midland 6971.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineering Inspection, 28 Victoria-street, London, S.W.1. (ABBey 3794.)
Institution of Engineers-in-Charge, 100 Earlsfield-road, London, S.W.18. (BATtersea 1394.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Railway Signal Engineers, Euston House, Eversholt-street, London, N.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Newcomen Society, Science Museum, Exhibition-road, London, S.W.7. (KENsington 1793.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. GROsvenor 3515.

In Parliament

DOCKYARD EMPLOYMENT

Questions on naval and Admiralty matters were to the fore during sittings of the House of Commons immediately prior to the recess. On December 21, Miss Joan Vickers (National Liberal and Unionist) asked for a declaration of Admiralty policy at the Royal Devonport Dockyard, in view of the reduction of the size of the Royal Navy, and was informed by Mr. Wingfield Digby, Civil Lord of the Admiralty, that there had been no change in the development plan as outlined to Plymouth Corporation in February last. Progress, he said, depended solely on capacity to undertake the work and on the availability of funds.

Asked if he was aware that £17 million worth of work, which could have been obtained for the naval dockyards had been put out to private industry, and that the dockyard was the only major industry at Plymouth, Mr. Digby gave an assurance that there was no shortage of work for the dockyard. When it was necessary to go outside to commercial shipyards, it was because the Admiralty had more work than could be placed with the existing dockyards.

Mr. Ronald Bell (Conservative) inquired about improvements in the status and prospects of civilian engineering dilutees in Admiralty employment. Mr. Digby replied that agreement had been reached on the Shipbuilding Trades Joint Council to extend the limit of merit pay for these employees from 9*s.* a week to 12*s.* a week as from June, 1955, and to 15*s.* a week in April, 1956. Discussions about improvements in the status of dilutees had taken place with the unions concerned and he hoped that further progress would take place.

Mr. Bell reminded the Minister that some men had been employed as dilutees for 15 years and that, if the engineering needs of the armament programme should be reduced before the problem was solved, the Admiralty would be faced with some acute personal problems, and Mr. A. G. Bottomley (Labour) urged that nothing should be done without full discussion with the trade unions. Mr. Digby replied that consultations were taking place and he was hopeful that something could be done in the way of recognition for skilled men who had performed their work satisfactorily over a number of years.

MORE NAVAL CONSTRUCTORS?

Miss Vickers asked whether, in view of the shortage of qualified naval constructors, consideration could be given to the formation of an intermediate corps of officers with professional experience in the fields needed in H.M. Dockyards. Mr. Digby said that the requirements for professional officers, both in the dockyards and elsewhere, were at present under consideration by the Admiralty. A number of complicated and difficult issues were involved and proposals similar to that of Miss Vickers were being examined, but he could hold out little hope of an early decision.

It was pointed out in a supplementary question that efficiency in private industry had been increased by the provision of extra supervisory staffs and it was suggested that similar methods should be tried out in the dockyards. Mr. Digby stated that this matter was being examined in connection with the position in other departments of the dockyards.

Mr. L. J. Callaghan (Labour) raised the question of the disposal of large fleet units and inquired whether, before parting with a number of such warships, including aircraft carriers, the Admiralty had approached Commonwealth Governments to find out if they would be prepared to maintain these vessels, either in commission, or in reserve, in their own countries. Mr. Digby replied that the condition of these ships was such that they could not have been recommended for acquisition by any navy, and there was thus no purpose in keeping them in reserve either here or overseas.

Asked if it was not the case that the Admiralty was about to dispose of a number of ships, including aircraft carriers, which were of post-war construction, and whether Commonwealth Governments had been approached, Mr. Digby said that the Admiralty was in the closest touch with these Governments, was well aware of their needs, and would offer them one of these ships if the occasion arose. He added that the problem of dispersing ships by placing them in reserve, which was a different matter, was at present being examined.

Commander C. E. Donaldson, R.C.N.(R.) (Conservative) referred to the alertness of the Commonwealth, and particularly of the Royal Canadian Navy, and said that it was surely not the policy to sell British ships to other countries simply because they were for disposal? Mr. Digby answered that the Canadian authorities were in the closest touch with the Admiralty and were well aware of what was for disposal, but he agreed with Mr. J. Dugdale (Labour) that these particular ships had not been offered to Canada, owing to their bad condition.

AGRICULTURAL MACHINERY BILL

A new measure to provide for the safety, health and welfare of persons employed in agriculture and certain other occupations, and to secure the avoidance of accidents to children arising out of the use, in connection with agriculture, of vehicles, machinery or implements, was presented by Mr. D. Heathcoat Amory, Minister of Agriculture, Fisheries and Food.

This Bill, which had the support of Major Gwilym Lloyd-George, Home Secretary and Minister for Welsh Affairs, and of other Ministers, was read for the first time on December 21 and ordered to be printed. Its full title is the Agriculture (Safety, Health and Welfare Provisions) Bill. The second reading is due to take place on January 24.

Atomic Energy Reactors

Replying to questions by Mr. Airey Neave (Conservative) and Mr. G. Nabarro (Conservative), who asked for details of any proposals by the West German Government to purchase atomic-energy research reactors from Britain, Mr. R. H. Turton, Joint Parliamentary Under-Secretary of State for Foreign Affairs, said that no specific commitment was entered into by either side during the visit of the Federal German Minister for Atomic Energy. He discussed with members of the United Kingdom Atomic Energy Authority the administrative problems involved in establishing and operating a civil atomic-energy project.

In the course of these conversations, it was made clear to the Minister that when the German authorities were in a position to make firm requests for assistance in the development of atomic energy for peaceful purposes, the Atomic Energy Authority would consider them sympathetically, subject to the availability of resources.

Gas Industry Pensions

Mr. Geoffrey Lloyd, Minister of Fuel and Power, was asked by Mr. J. M. Howard (Conservative) if he would investigate the position of pensioners in the gas industry who had retired before the nationalisation of the industry, in order to ascertain whether anything could be done to compensate them for the inadequacy of their pensions under present conditions. Mr. Lloyd said he was informed that the Gas Council was considering the matter and that it hoped to submit proposals for the Ministry's approval in due course.

Electricity Superannuation Scheme

In answer to a question by Mr. A. Henderson (Labour), Mr. Lloyd stated that the new superannuation scheme of the Central Electricity Authority was designed to cover manual workers for whom no provision had previously been made. Former employees of the Midland Electricity Corporation were not eligible to join because they were already covered by arrangements which existed prior to nationalisation.

Electricity Breakdown at Newcastle

Information was sought by Dame Irene Ward (Conservative) and Captain E. W. Short (Labour) regarding the breakdown of the electricity supply services at Newcastle-upon-Tyne on December 14. Mr. Lloyd stated, in a written reply, that preliminary reports so far received showed that this interruption of supply was caused by an explosion at 8.30 a.m., on that date, in the switching gear at Stella South substation, which is part of the Authority's grid transmission system. It affected switchgear at other points as well as the circuits leading from Dunston Power Station, and interrupted the supply to the North Eastern Electricity Board's distribution system covering Northumberland and North Durham.

Supplies were partially restored by noon and fully by 6.30 p.m. on the same day. It was provisionally estimated that about 300,000 kilowatts of power were lost. The cause of the explosion was still under investigation.

Use of Scientific Manpower

Asked by Mr. W. W. Hamilton (Labour) about his recent discussions in the United States concerning the more efficient use of scientific manpower, Mr. R. Maudling, the Minister of Supply, said that, during his visit to Washington, he had discussed in general terms the possibility of even closer co-ordination of research and development activities in the defence field. He had reached no specific conclusions, but he had arranged for the Ministry's representatives in Washington to re-examine in greater detail with the U.S. Department of Defence certain possibilities to ensure that Britain was making the most effective use of her scientific manpower in the defence field.

Duty-Free Machinery Imports

Mr. John Arbuthnot (Conservative) asked for a statement regarding the recommendation of the Wilson-Smith Committee on the Duty-Free Entry of Machinery, in favour of extending the duty-free licensing provisions to plant.

Captain Peter Thornycroft, President of the Board of Trade, stated, in a written answer, that, after a full examination of this matter with the consultative committee of the Board of Trade, the Government had decided that there was not a case in the national interest for extending these arrangements to plant. This decision had been arrived at on a balance of the practical considerations involved and, accordingly, the Government was not proceeding with the recommendation of the Wilson-Smith committee.

Registration of British Ships

Mr. H. Hughes (Labour) asked if the Minister of Transport and Civil Aviation was aware of the menace to British shipping caused by the registration of British ships under foreign flags and of their wearing flags of convenience. Mr. Boyd-Carpenter replied that British ships were registered under the British flag and that he was not aware of any such practice on the part of British owners. He was, however, much concerned about the growth of this practice on the part of foreign owners, who were outside British jurisdiction.

Kingsway Tunnel

The question of using the old London tramway tunnel, from the Victoria Embankment to the top of Kingsway, Mr. Boyd-Carpenter informed Captain H. B. Kerby (Conservative), had recently been examined by the London and Home Counties Traffic Advisory Committee. Their advice, with which, Mr. Boyd-Carpenter said, he agreed, was that there was no traffic use for the tunnel at the present time without a prohibitive expenditure of funds, which could be better used on the roads elsewhere. The Committee would consider the matter again in 1957.

THE HUMAN ELEMENT

Catholic Church v. *Communism—French employers offer a wage increase—Opposition to foreign recruits—Trade union leadership—Aviation workers' employment conditions—Race between prices and wages.*

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Anti-Reds

The fight being waged by the Catholic Church against Communism has been intensified since the Rolls-Royce strike. It is playing a major part in the election of a President to the A.E.U., and in the election of new shop stewards at the three Rolls-Royce factories in Scotland. The results announced so far, however, do not suggest very much change in the representation of "left" and "right." At the Hillingdon factory three Communist candidates have been defeated but another three have been reported elected in place of non-Communists. The activities of the anti-Communist group, stimulated as they were by Press publicity, have angered existing shop stewards who are pressing the A.E.U. for an inquiry into the group's "disruptive activities."

A number of well-informed and influential people, including a good many non-Catholics, have become alarmed at the progress of Communists in the trade union movement. This, they say, is due mainly to apathy among the majority of workers who do not bother to vote or to attend meetings. Whip them into action and the red threat disappears overnight. This does, however, raise the question of politics and religion in trade unionism. Greater political conscientiousness may throw out the extreme left but it may also generate a great deal of heat which could disturb the present elected leaders of the movement. The promotion of active democracy in the trade union movement is doubtless welcome, at any rate in theory; it remains to be seen how far the radical change in workers' attitudes that it entails would affect the stability of the unions.

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Fraternity in France?

When the management of the big Renault factory in Paris made a wage agreement with the unions last September it made a key tactical move which is all too often forgotten in management-labour relations. It made an offer before it was approached by the unions with demands. This hold of the initiative is paying dividends to all concerned. The Renault agreement provided for an immediate increase in wages of 3 per cent. and a further increase of 4 per cent. in each of the next two years. Paid holidays were increased as well. In return the unions agreed not to strike except as a last resort.

Other plants in the car industry followed suit. It could be argued that this was to be expected in such a prosperous industry once the Renault management had given a lead, but last week a quarter of a million French miners accepted a similar arrangement. The agreement was negotiated with the two non-Communist unions but the C.G.T. (which claims 70 per cent. of the miners as its members) is clearly at a tactical disadvantage if its hostility to the agreement takes an overt and active form. It may indeed accept the scheme in the end, as it did the Renault one. Under the arrangement, the miners get an immediate increase of 3½ per cent. plus a further 3 per cent. in 1957 if productivity increases at the present rate. Productivity bonuses are also to be increased. Holidays with pay are raised. In return, the unions agree not to resort to lockouts or strikes until conciliation machinery has been used. The idea of the longer term wage contract is clearly gaining ground even if it is coming in through the back door.

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Italians Again Unlucky

The railwaymen have said "No" to the recruitment of Italian labour to do unskilled work on British Railways. Like the miners before them (The Human Element, August 12) they do not consider that such a step is at all appropriate to the needs of the situation.

The argument put forward by the National Union of Railwaymen in reply to the British Transport Commission's proposal to recruit 2,000 Italians—one-tenth of the total vacancies on British Railways—is basically the same as the argument put forward by the National Union of Mineworkers in reply to the Coal Board's proposal: "Improve the working conditions and the remuneration of the industry, make working on the railways an attractive career, and there will be no shortage of British recruits." This could and always will be said in every industry where an attempt is made to reduce the shortage of workers by recruiting foreigners. But the fact remains that the country as a whole is short of workers, and no purpose whatever will be served by a nice game of musical chairs. To improve working conditions and wages in one industry can obviously only solve its own recruitment problems by creating a shortage elsewhere.

Much of the N.U.R.'s reply is sound commonsense. They point out that any Italian recruits, once their contract with the B.T.C. expired, would move on to better paid jobs. This was no way, in their view, to solve the staffing problems; it was a make-shift solution and against the railwaymen's interests. They suggested that the problem of the country's shortage of labour should be tackled nationally and not by approaches to individual unions. The obvious difficulty from the Government's point of view is that any national scheme must ultimately depend upon the acceptance by trade unions of foreigners within their ranks. More than that even, it depends on the acceptance of foreigners by the men themselves and, as past experience in the mines has already shown, the men might well reject any scheme even if supported by their union leaders.

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Whither the T.G.W.U.?

The Transport and General Workers' Union has for many years played a conservative role in trade union affairs. Under the tutelage of Ernest Bevin, Arthur Deakin and A. E. Tiffin (who died just after Christmas) it has thrown its very considerable weight on to the side of moderation. It is an open question whether it will continue to do so for much longer.

In order to survive in its present somewhat ramshackle form (it was, after all, built by architect Bevin as an edifice of utility to withstand the rigours of the trade union climate rather than as a thing of beauty) it must have strong men at the top. The two most likely candidates for the position of general secretary are both probably capable of fulfilling that qualification; they are also left-wing in their views. It is no mere coincidence that during the recent illness of Mr. Tiffin his lieutenants pushed the union further to the left and adopted a more militant attitude in their wage negotiations.

The implications of all this are important, especially at the present time. There is a long-term and a short-term issue involved. In the long term, if the T.G.W.U. moves to the left it will change the political balance of power in the trade union movement—for a time at any rate. In the immediate future, this swing is likely to occur at a time when the whole trade union movement is adopting a more militant attitude on wages and that attitude will thus receive impetus from a fresh quarter—as it has been doing of recent weeks. It is, of course, possible that power and public position may bring moderation to certain individuals.

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I.L.O. and Aviation Workers

The International Labour Office's decision to survey the conditions of employment of civil aviation workers will be generally welcomed. The industry has grown at a faster rate than almost any other and there are wide differences in working conditions between countries, and even between airlines within the same country. The I.L.O.'s object—it might best be expressed as their hope—is to formulate internationally valid regulations to govern such things as hours of work of flight personnel, off-duty time, and "income security" after retirement or grounding. They point out that although one fourth of I.L.O. Conventions relate to seafarers there is as yet no international standard to protect aircrews or civil aviation personnel generally.

The importance of avoiding extreme fatigue of aircrews is obvious enough. It is probably more of a truly international problem, now that airlines criss-cross the world, than any other question that has come before the I.L.O. It should therefore be well supported. One may hope that inquiry will lead to sensible international regulations which, once agreed, are strictly carried out. Unfortunately this is not so in the case of the international regulations governing the conditions of employment in ships. Despite I.L.O. conventions it is still the practice of some shipping lines to transfer tonnage to flags under which the oldest ships with cramped quarters can be manned by underpaid crews.

The I.L.O. are inviting the International Civil Aviation Organisation to send representatives to an *ad hoc* meeting to be convened later this year. A committee will consist of 20 members appointed by the Governing Body, half on the nomination of employers' members of that body, and half on that of the workers' members, together with a Government chairman. The recent admission to I.L.O. membership of Soviet bloc countries should ensure that this meeting is truly international. It is unfortunate that air travellers cannot be represented.

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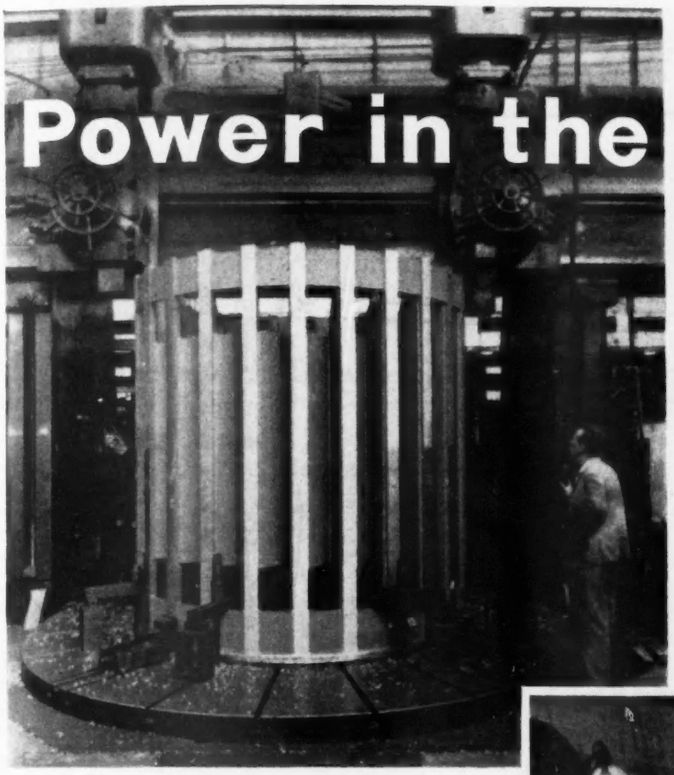
Prices and Wages

The futility of trying to keep wages ahead of prices at a time when inflation is even mildly out of hand has been shown again with the recent publication of the latest wage and retail price indices. For most of the year 1955, wages kept ahead of the cost of living, but in November the retail price index rose by two points to 154 (June, 1947, being 100). Over the same month the wage index increased by one point to reach 154 as well.

The race is perpetuated by the failure of all concerned to handle the root cause of the problem, which is that the country's resources are expected to do more than they are capable of accomplishing. Taking a short view, the upward movement does not look very serious but over a period of time the tale is more ominous. In the last year, the hourly earnings in manufacturing industry in this country have increased more rapidly than in any major industrial country—so has the retail price index. In contrast, this country's record in the rate of increase in industrial production and the average weekly hours worked in manufacturing industry is among the worst.

Taking hourly earnings in manufacturing industry over the last few years as a rough indication of comparative competitive power, this country is also at a disadvantage. Since 1951 the rate of increase in hourly earnings in this country has been higher than in any of its important competitors. This has nothing to do with the question of paying good wages. It means, taken in conjunction with the other statistics, that wages are rising more quickly in this country than elsewhere, unsupported by comparatively greater output.



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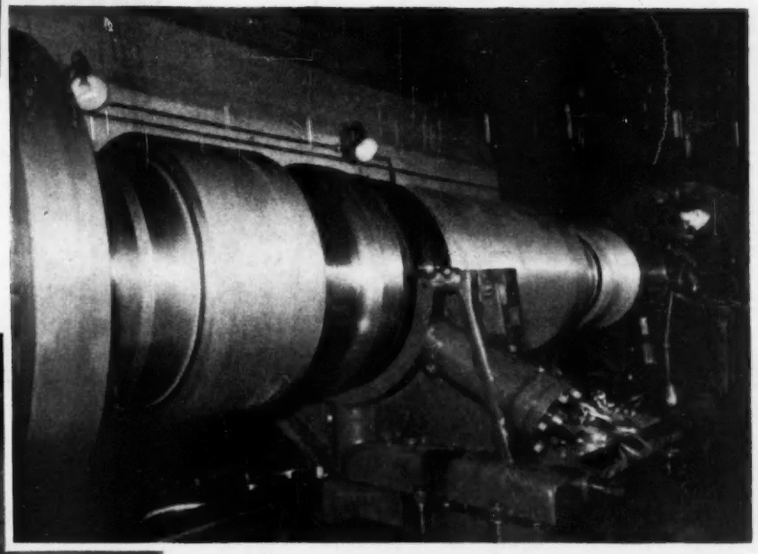
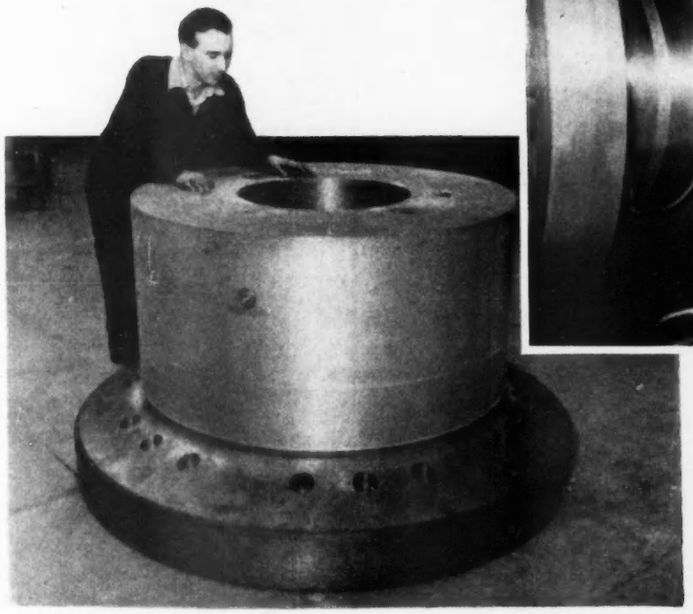


Machining the rotor shaft. The completed rotor will weigh 300 tons.



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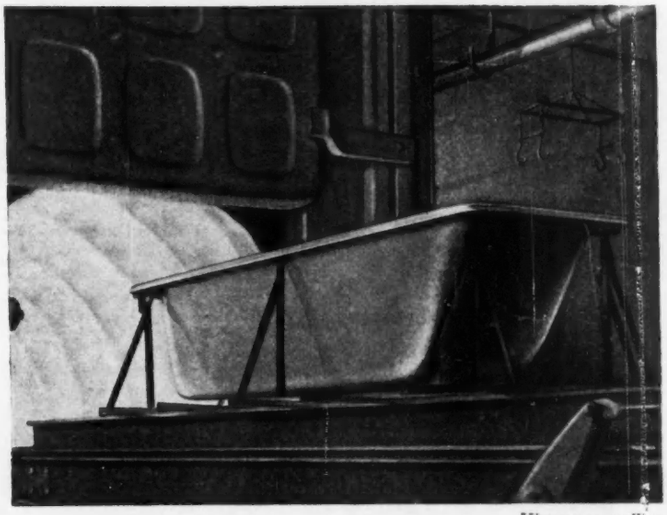
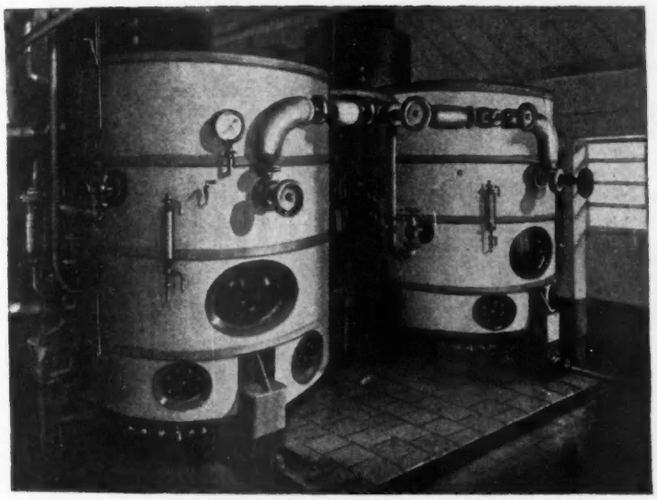


Vitreous enamelling



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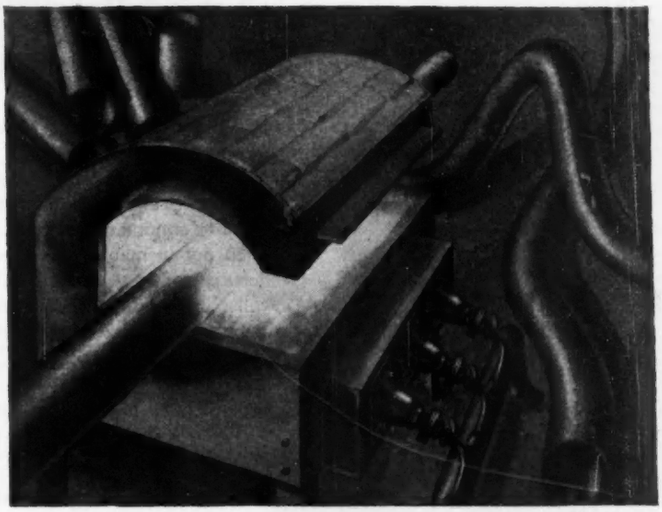

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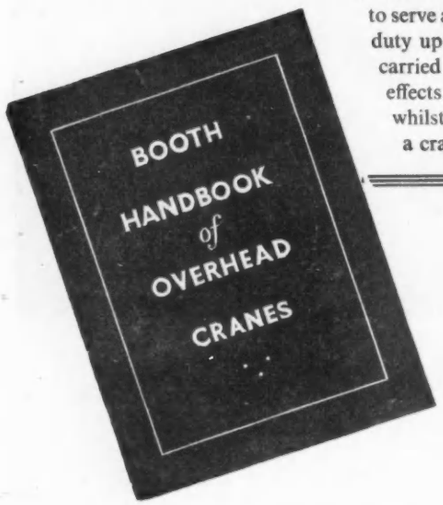

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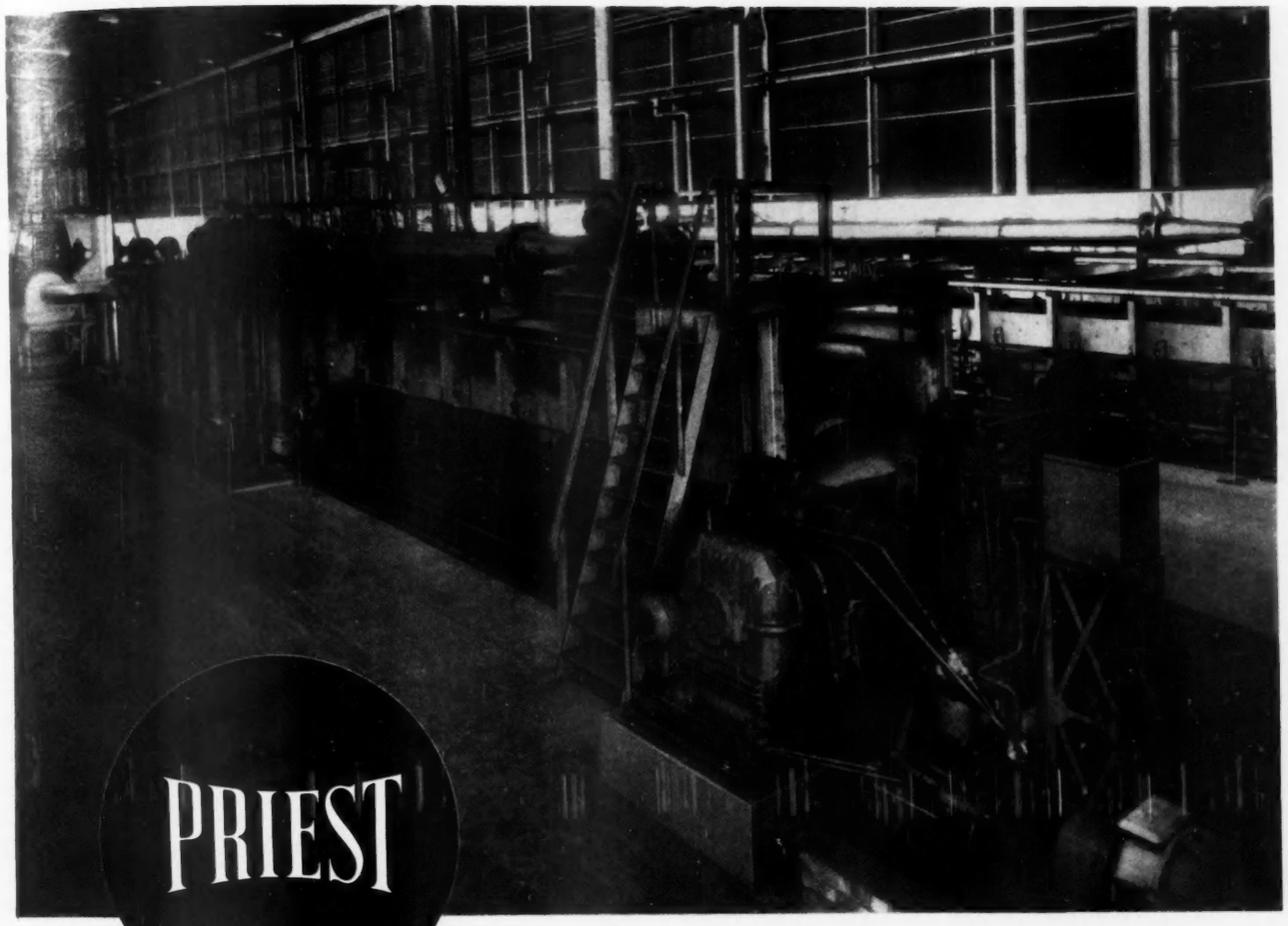

PRIEST

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This Towns Gas Fired Continuous Heat Treatment Furnace is installed at The Shepcote Lane Rolling Mills Ltd., Sheffield, for softening Stainless Steel Strip. The furnace is of the semi-muffle type to prevent deterioration of stock during heat treatment.

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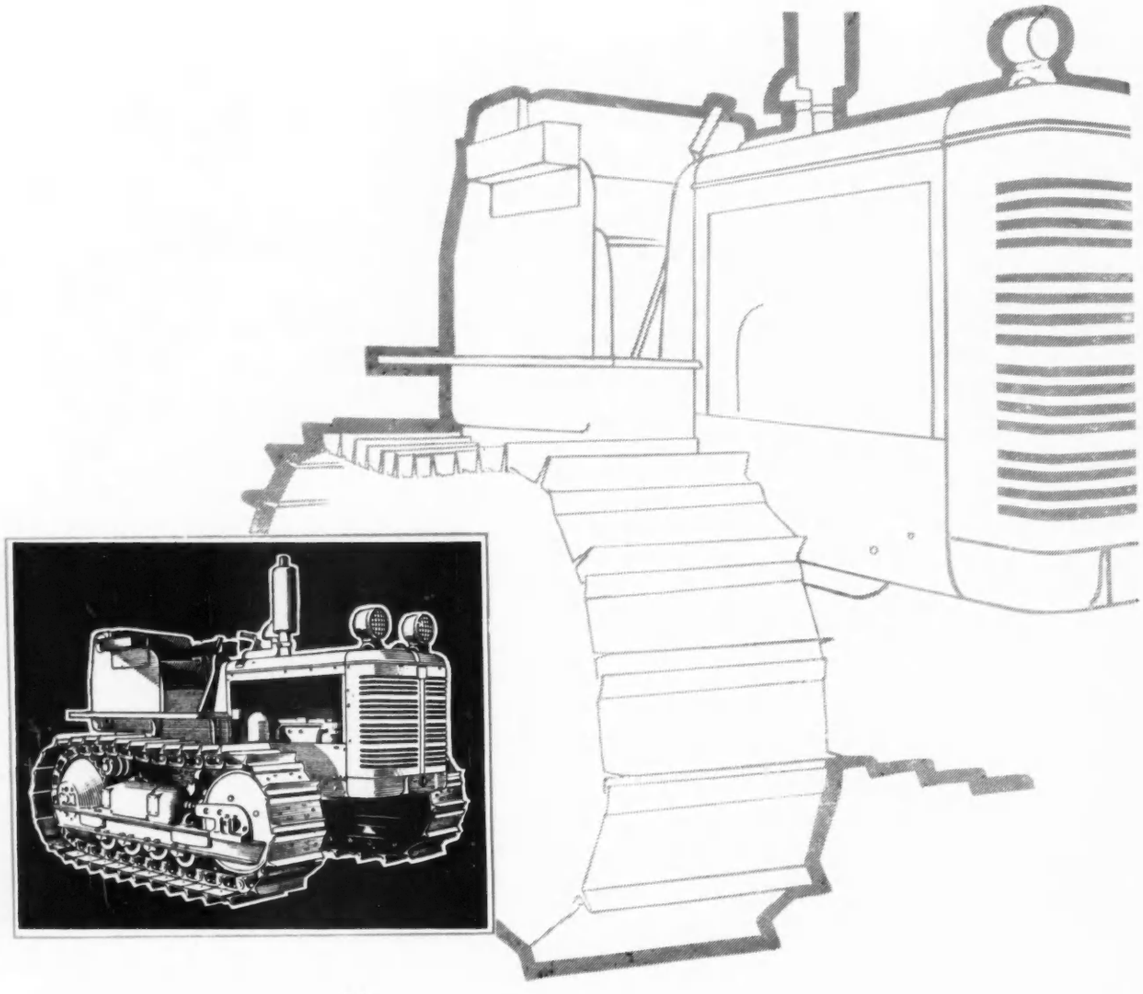

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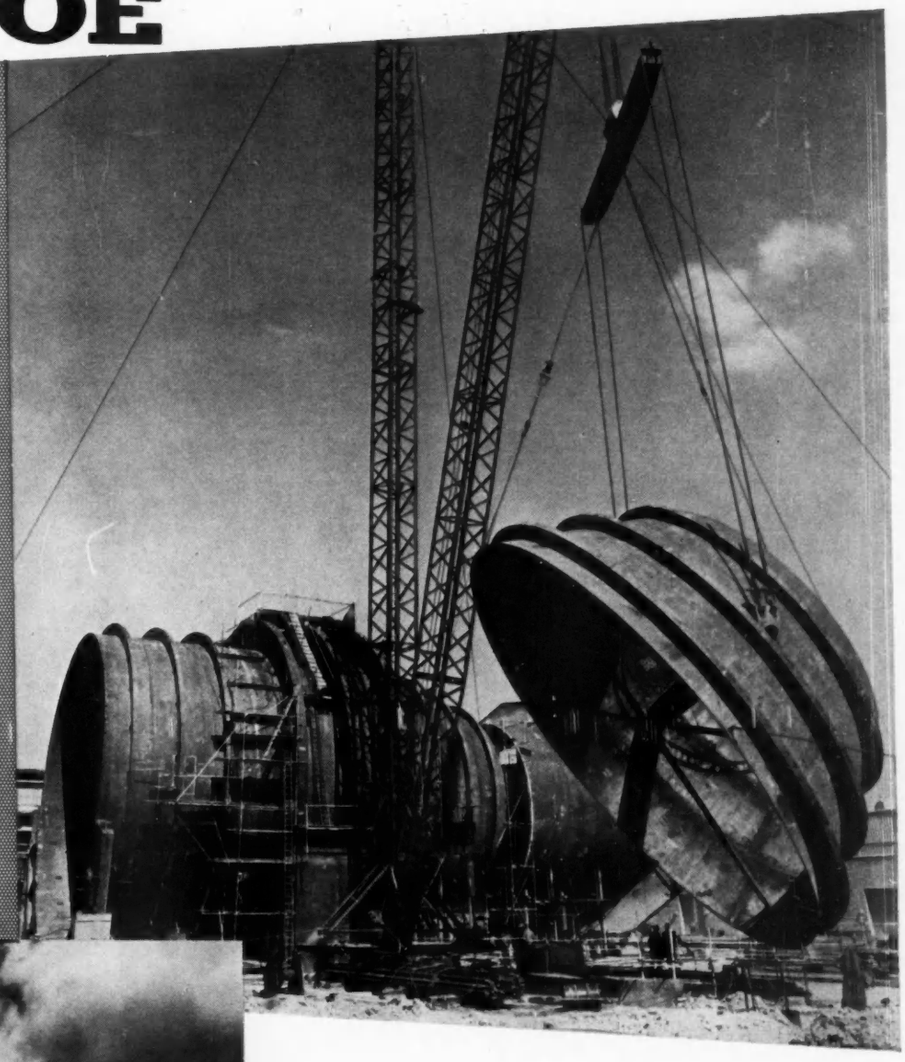

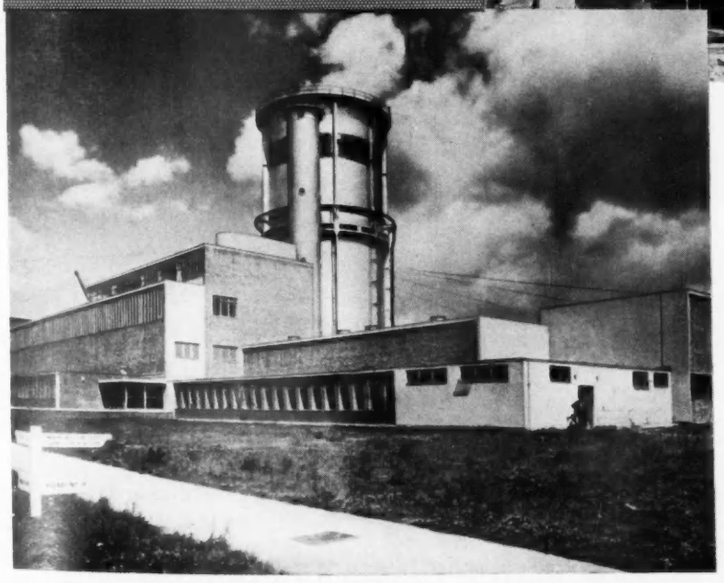

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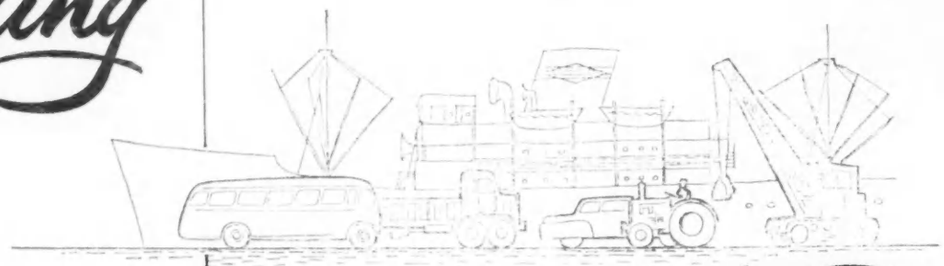

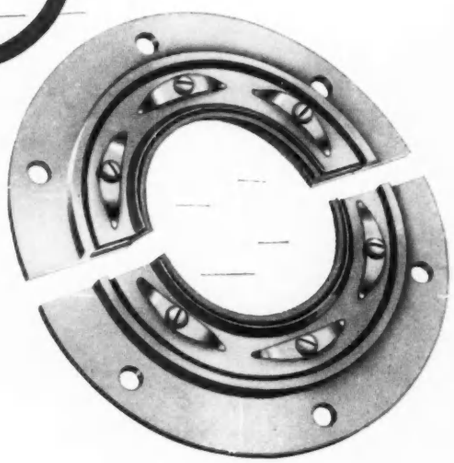

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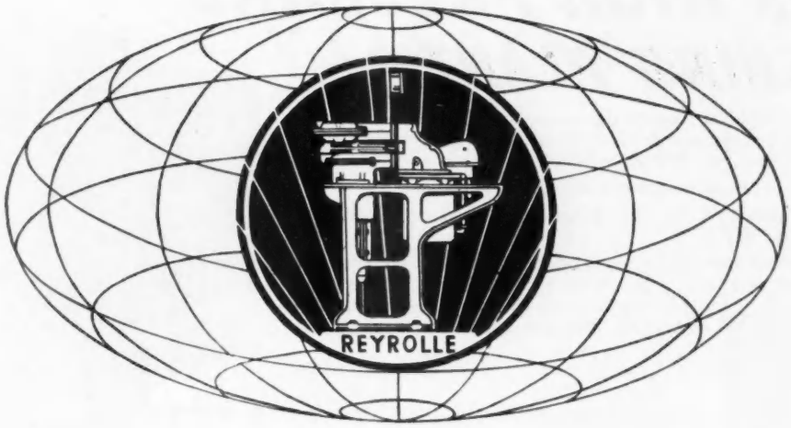

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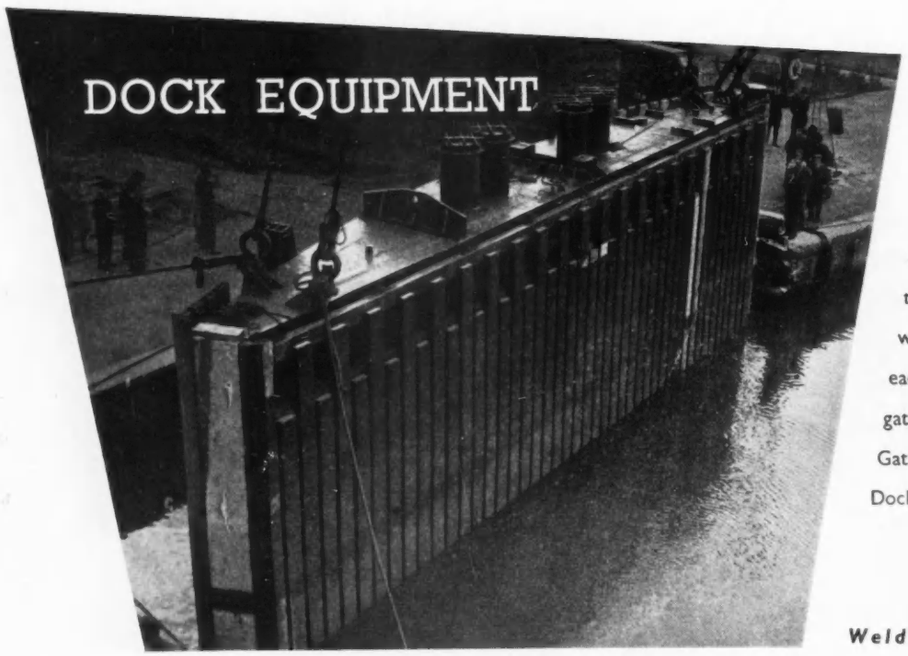

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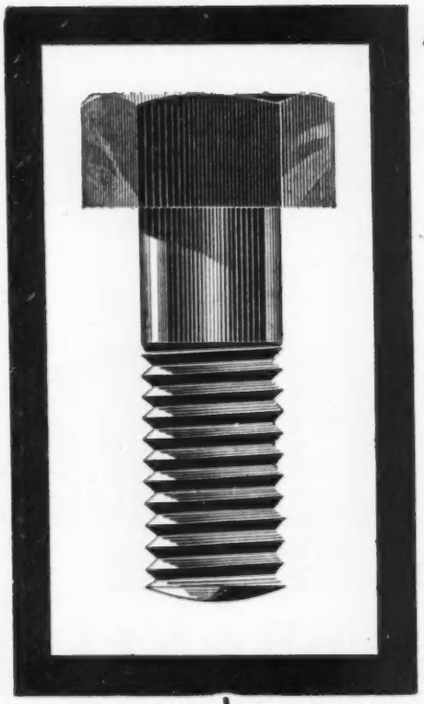

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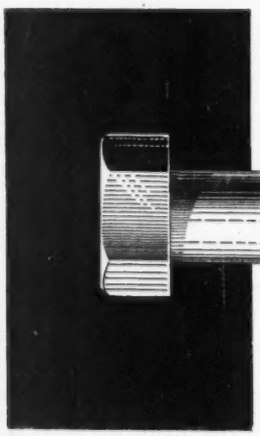

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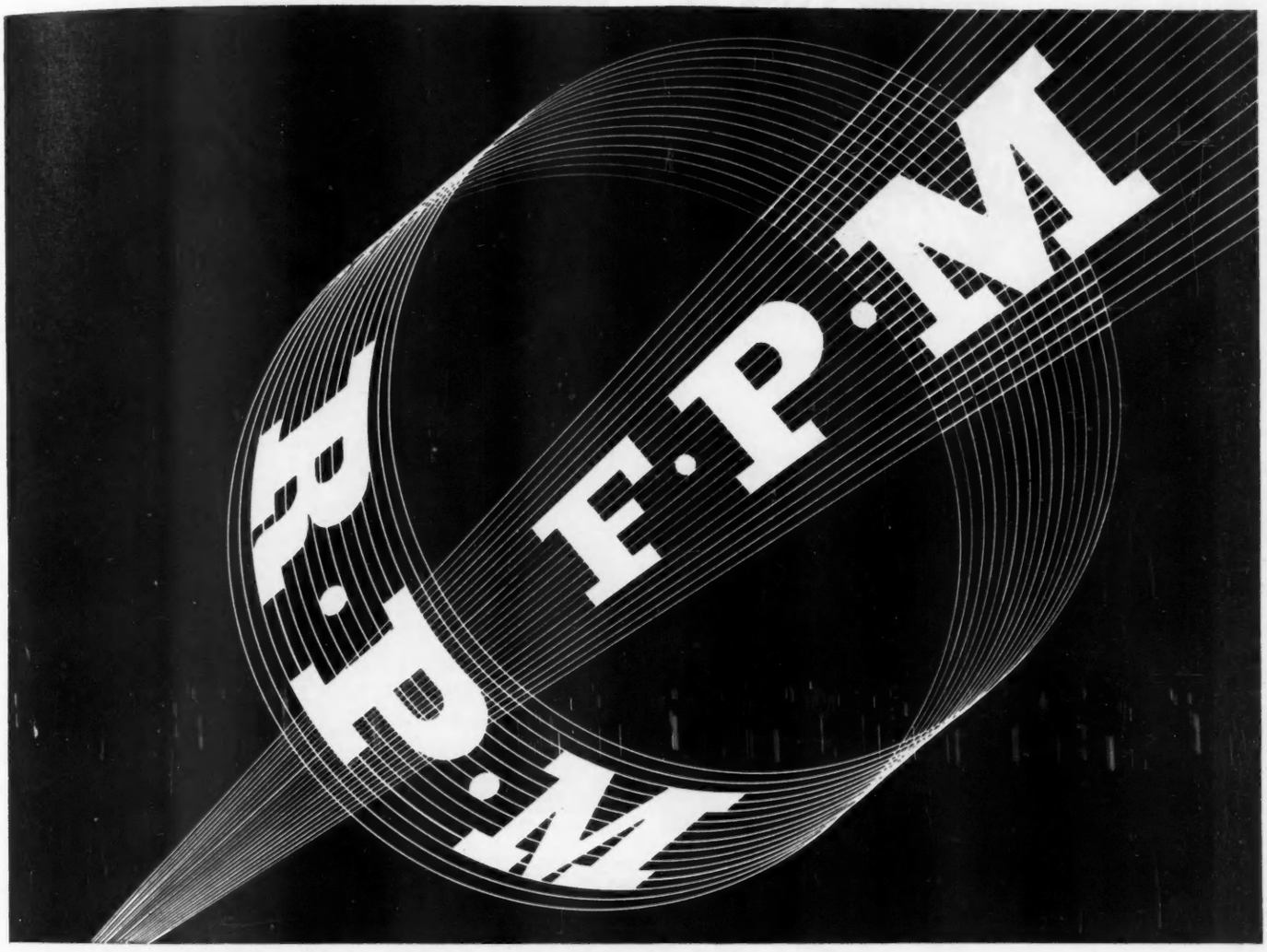

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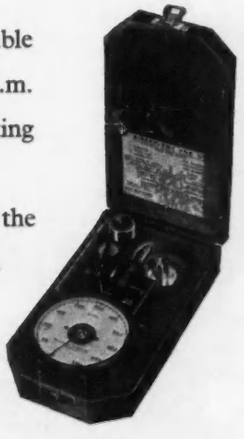

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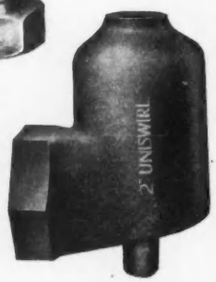

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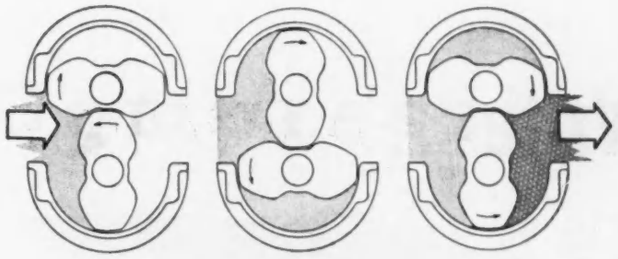

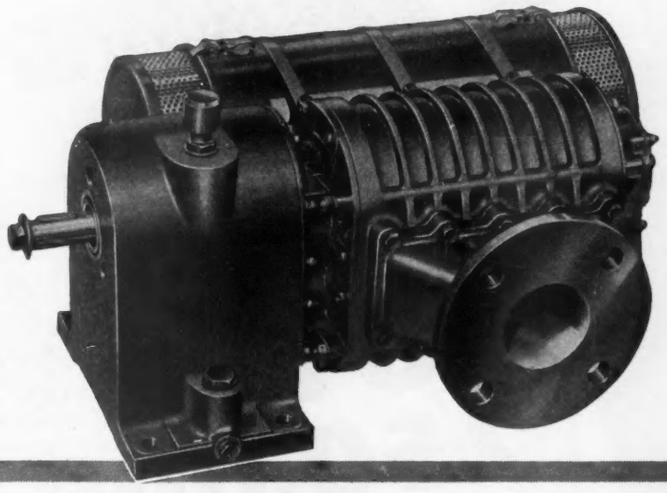

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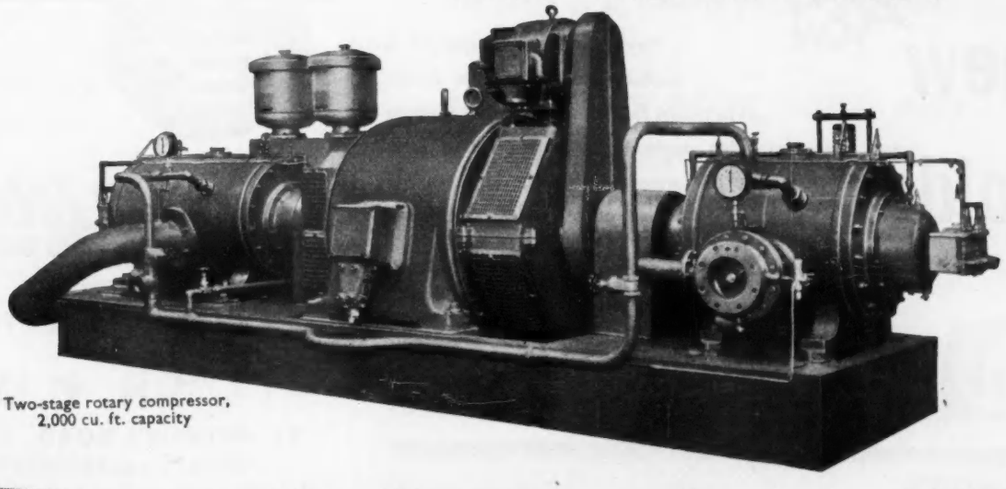

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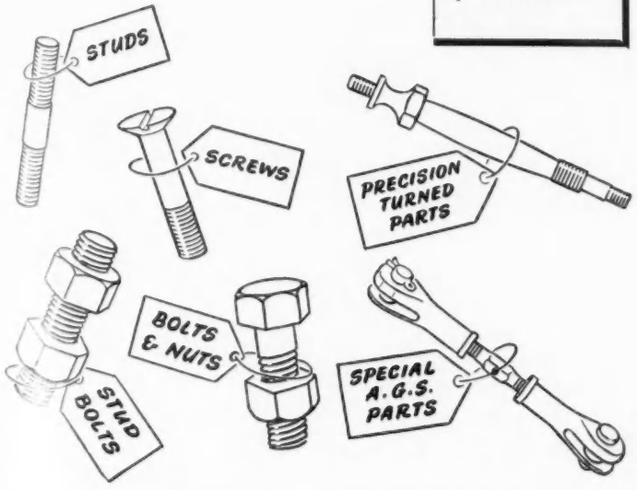

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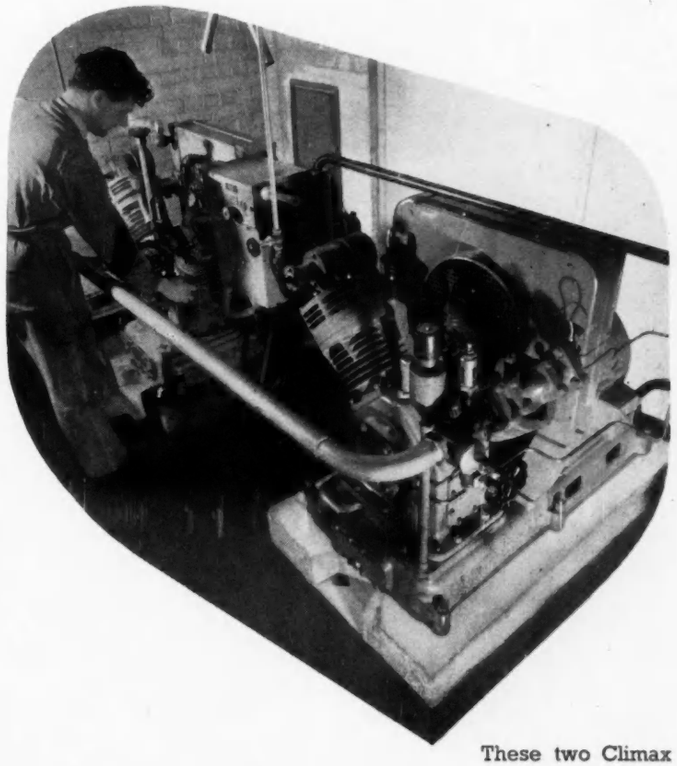

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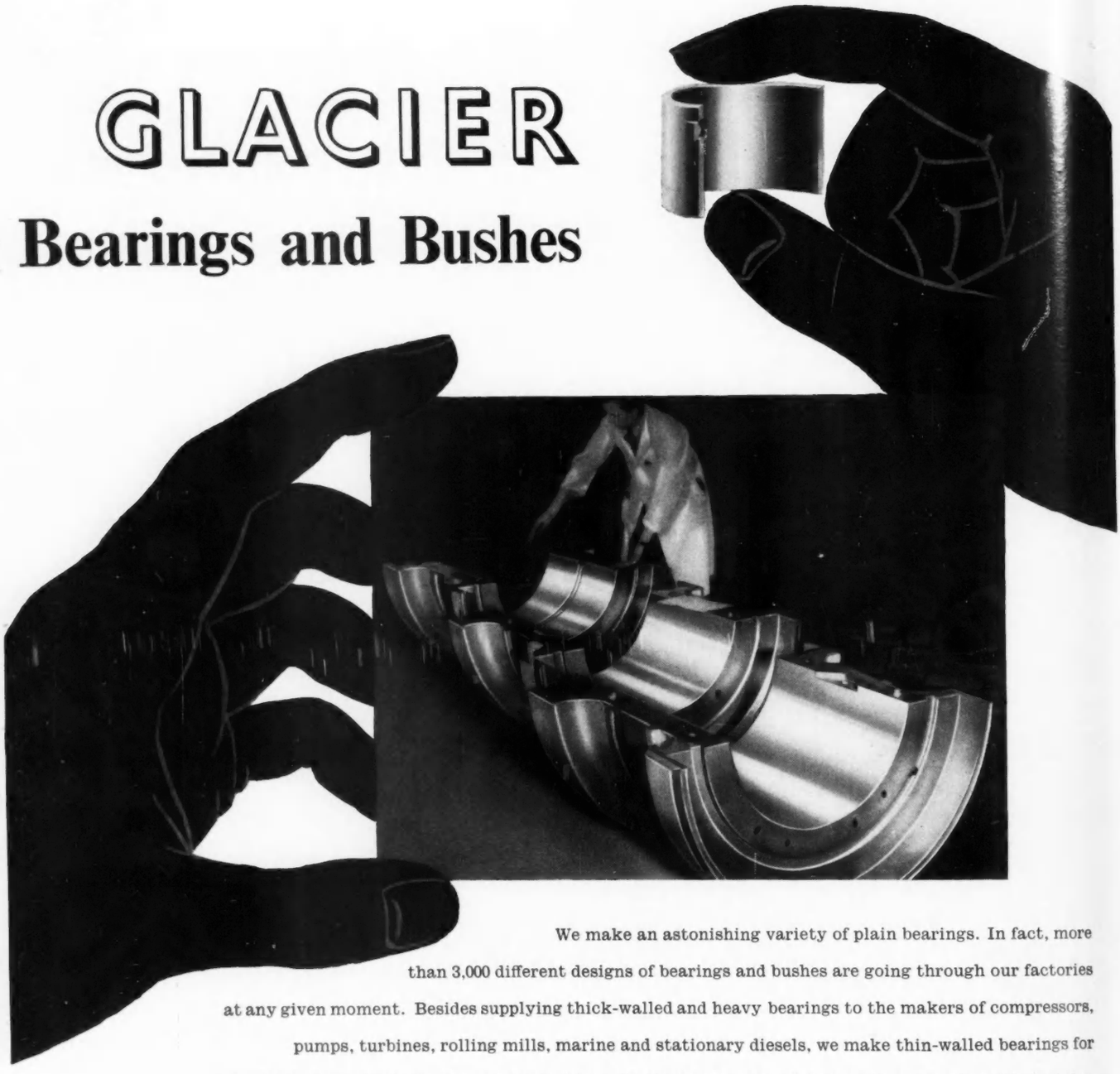

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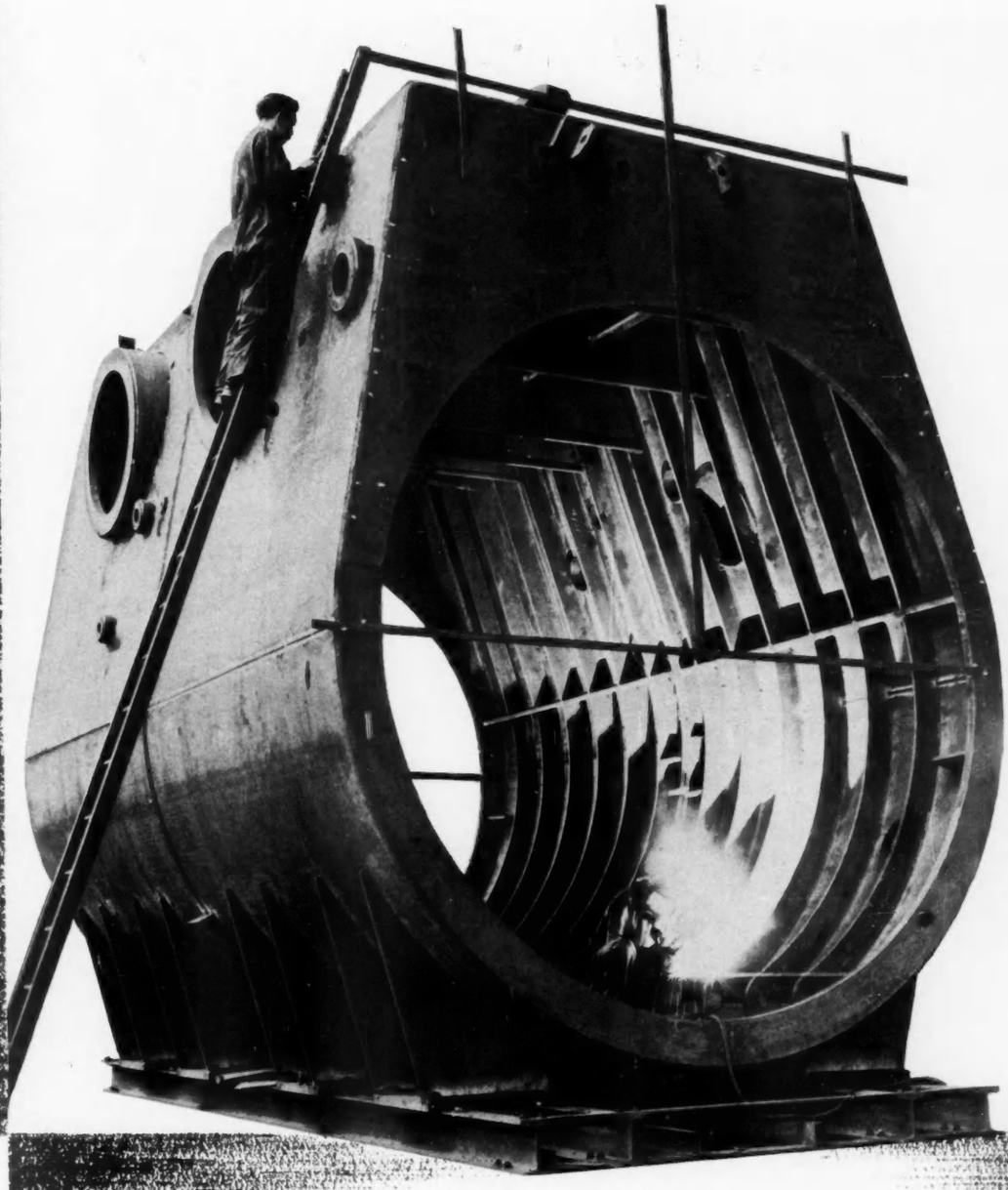

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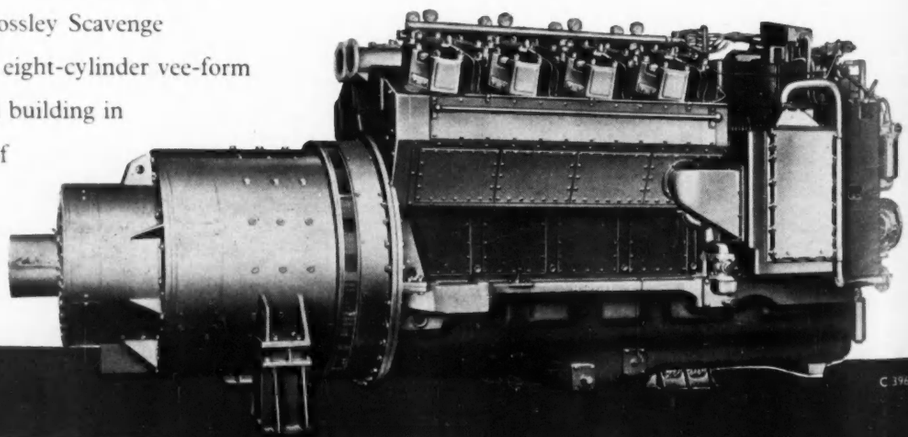

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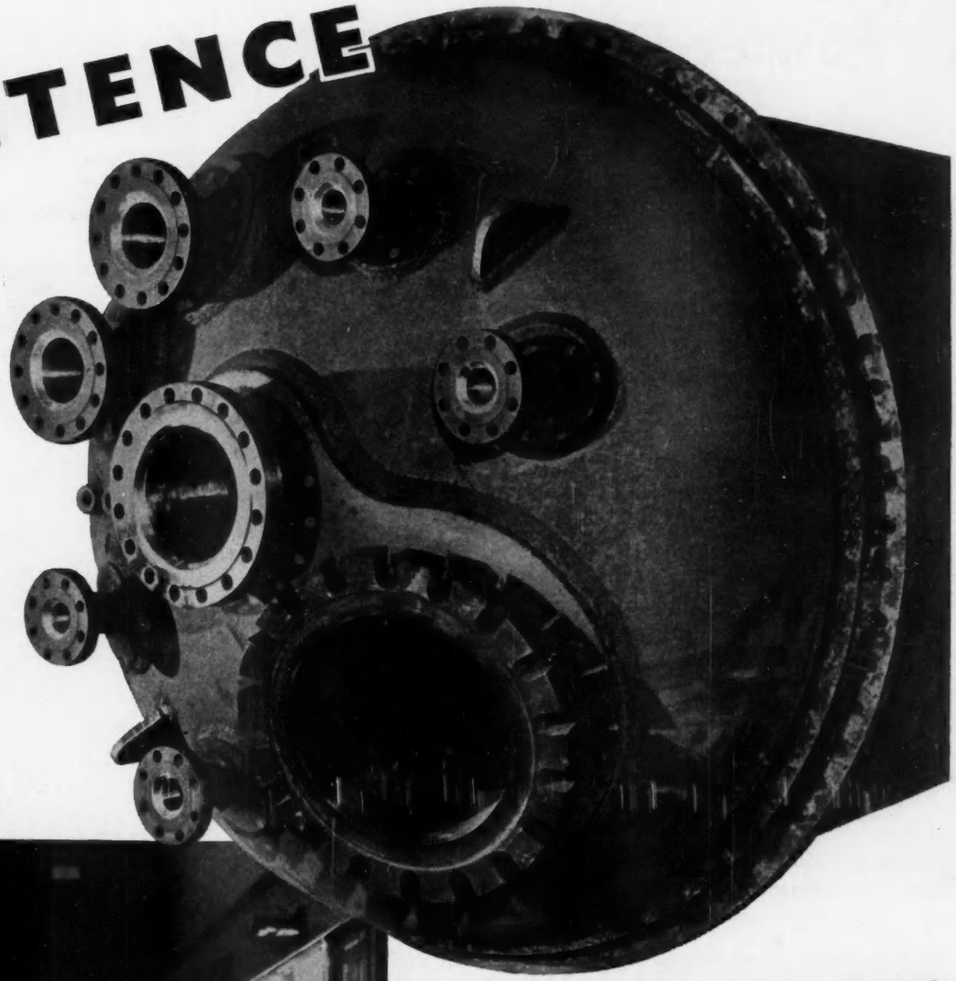

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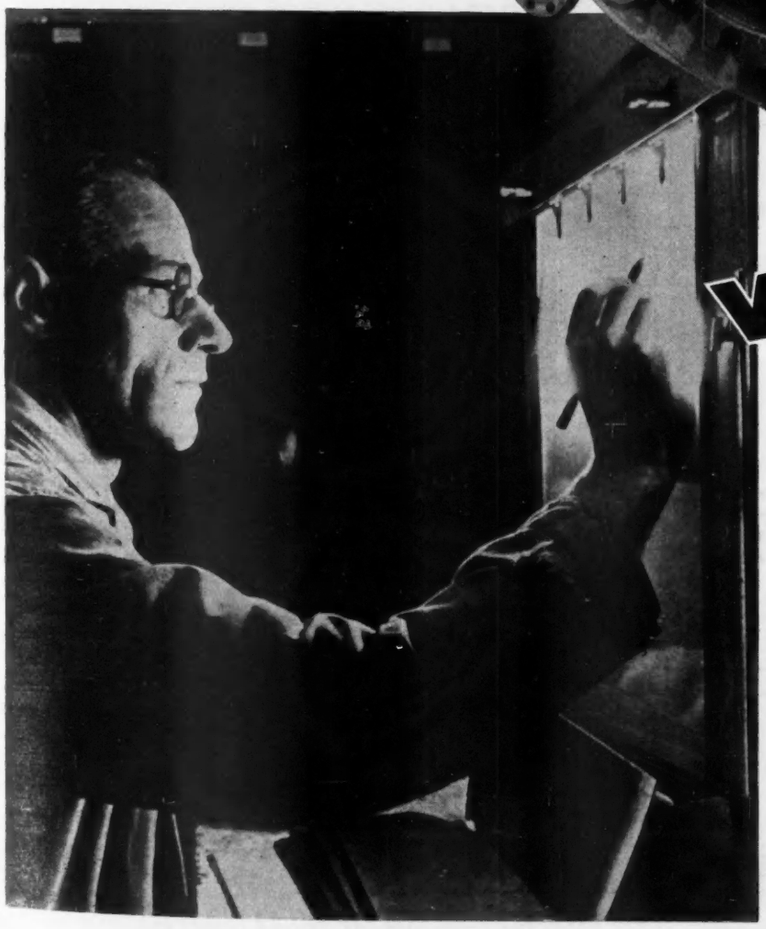

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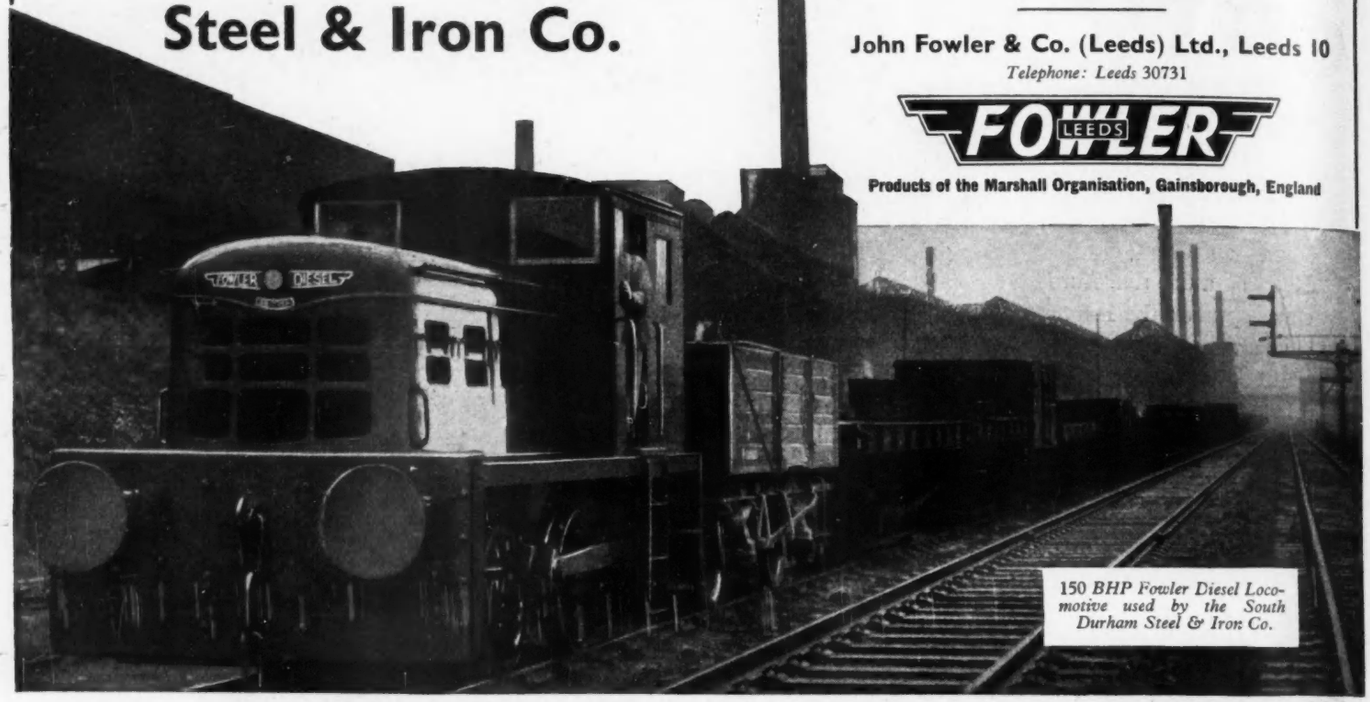

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S 33

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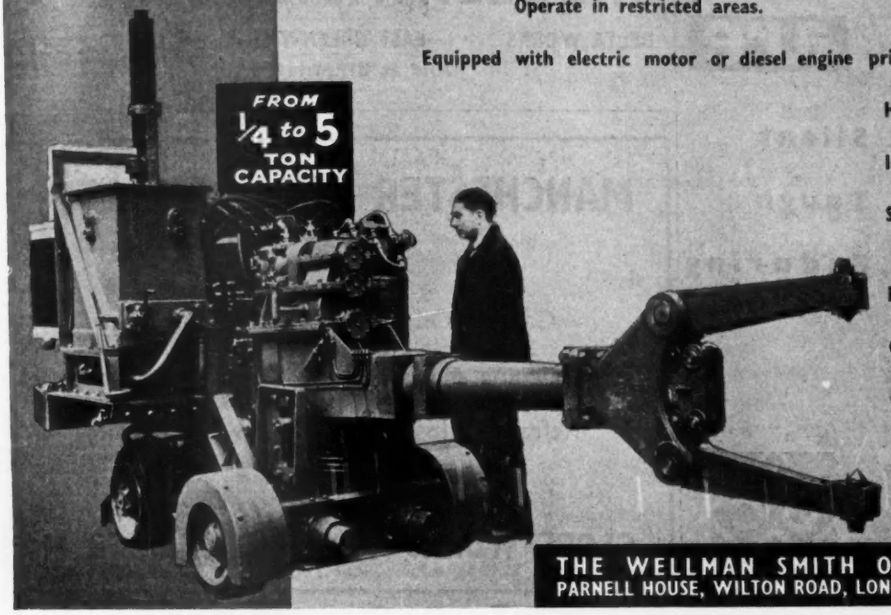

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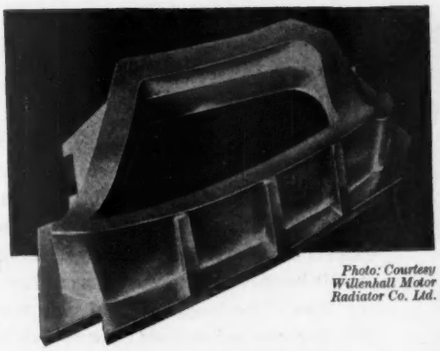

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Cost of dies made with KIRKSITE 'A' is only a fraction of those made of steel or cast iron, the more intricate the tool the greater is the saving. Use of KIRKSITE 'A' also means that dies can be produced in a few days eliminating long waiting periods for tools. A complete and speedy service for the production of both patterns and dies is operated. KIRKSITE 'A' data gladly sent on request. Also the Hoyt Buyers' Guide, listing all the Hoyt products and services.

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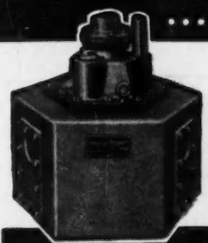

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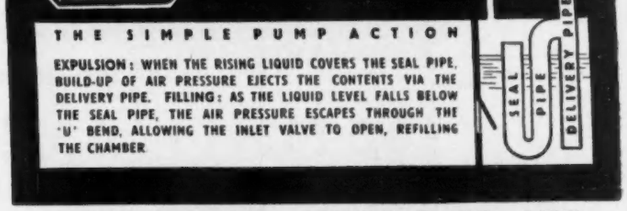

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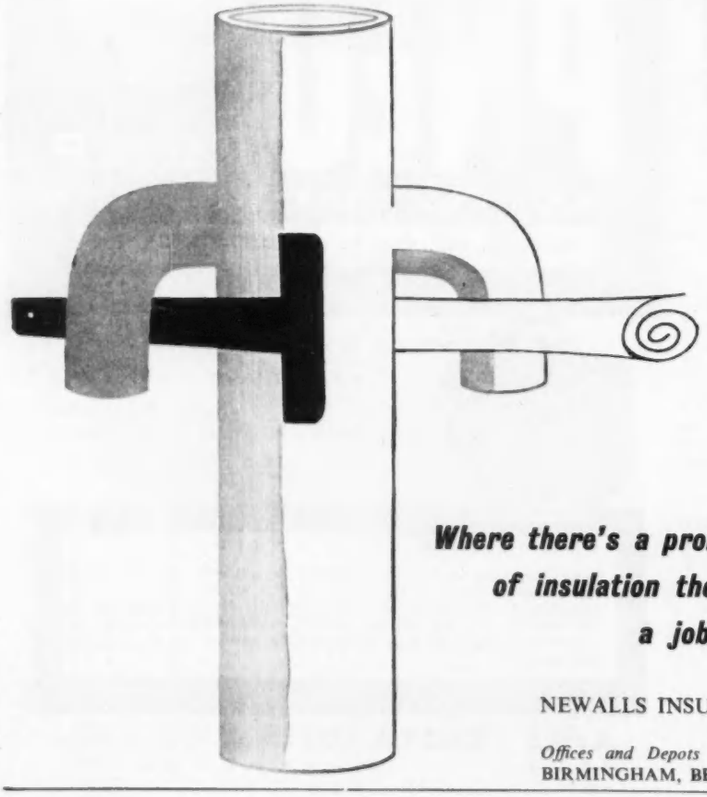

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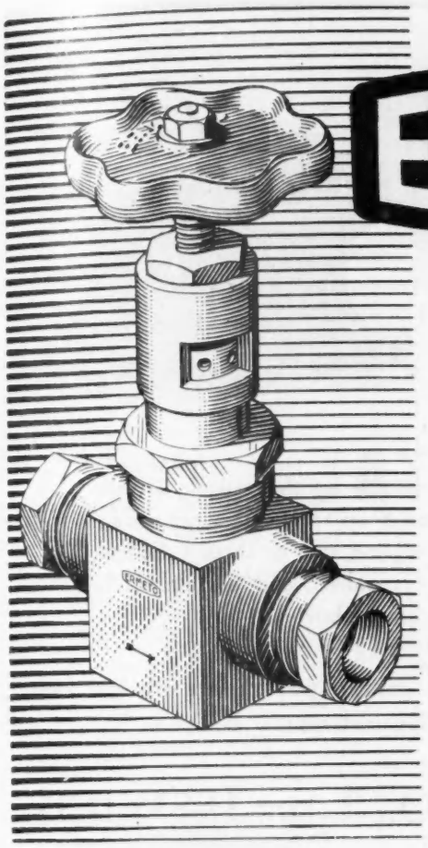

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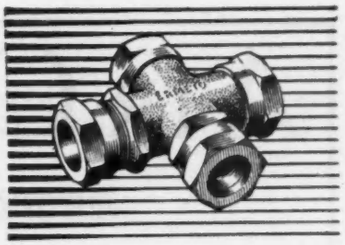

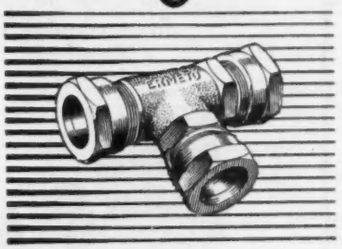

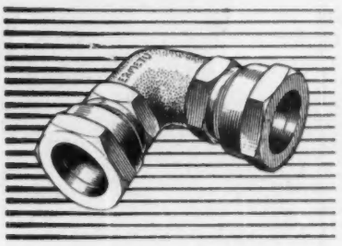

are standard equipment where pressure tightness, even in conditions of great stress, is an essential requirement. Joints made with Ermeto couplings can be broken and re-made for an indefinite number of times without impairing their efficiency.

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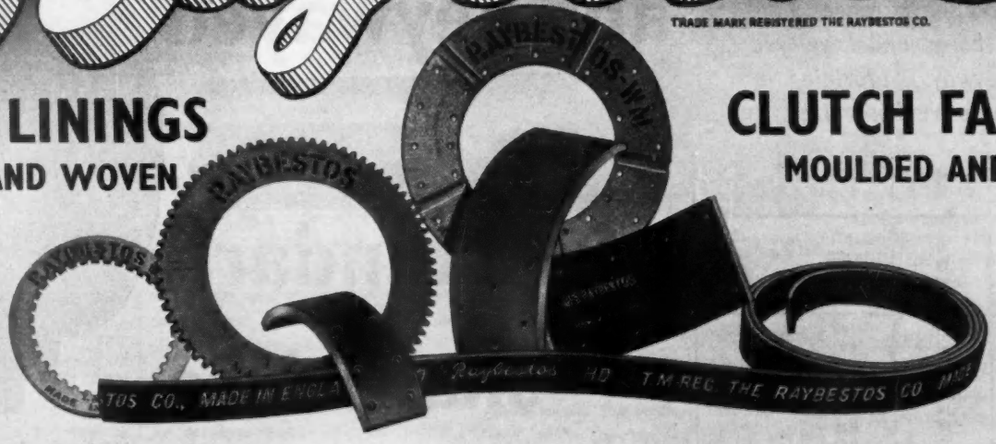

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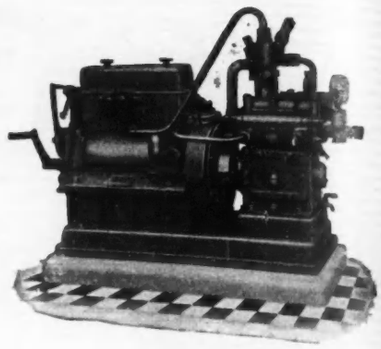
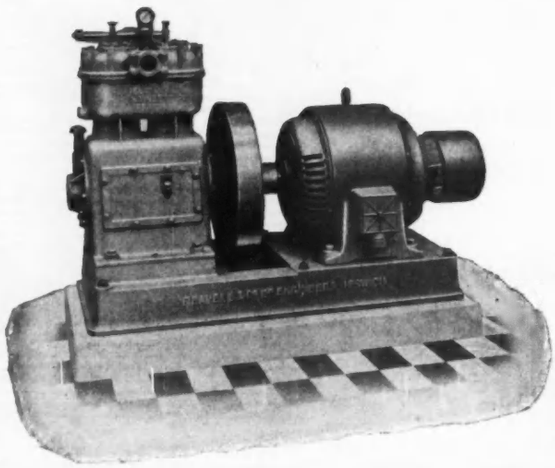
VERTICAL SINGLE-ACTING TYPE.



Two-stage compressors similar to that illustrated on the right are made in three types for pressures up to 450, 600 and 1000 lbs. per square inch. They are belt driven or direct coupled to electric-motors, petrol or Diesel Engines.



Single-stage compressors similar to that shown on the left are suitable for pressures up to 100 lbs. per square inch. They are made with one, two or three cylinders, according to the capacity required, and are driven in the same way as the machines above.

For full information write, giving particulars of the duty required, to Department "B."

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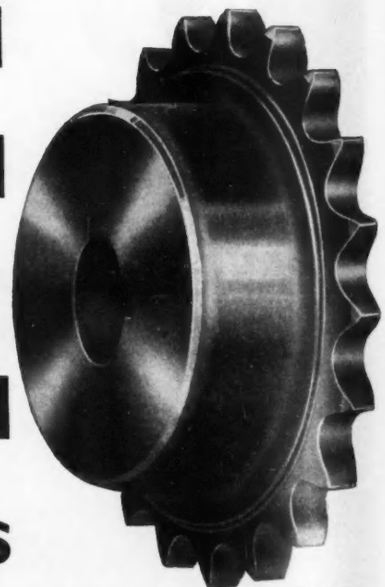


CHAIN PITCH	NUMBER OF TEETH	ALTERNATIVE STOCK BORE SIZES	B.S. TAPER KEYWAY
in.		in.	in.
·375 (No. 110 038)	17	·625	·1875
	19	·75	·1875
	21	1·0	·250
	25		
·5 (No. 110 046)	19	·75	·1875
	21	1·0	·250
	23	1·125	·3125
	25	1·25	·3125
·75 (No. 110 066)	19	1·0	·250
	21	1·25	·3125
	23	1·5	·375
	25	1·625	·4375

Write for Leaflet Ref. 216/195

STOCK PINIONS — FROM SHELF TO SHAFT!

RENOLD

RENOLD CHAINS LIMITED MANCHESTER

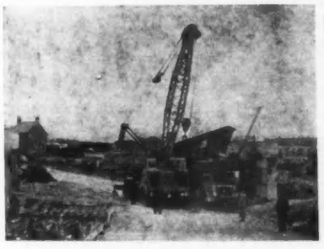
news about COLES cranes

Another 'Colossus' Triumph —29 ton girder positioned in 14 minutes

Three 76 ft. steel bridge girders, one 29 tons and the others 22 tons each, were lifted from a transporter and accurately positioned on a new railway bridge structure within the space of 14 minutes each.

The crane that achieved this feat was the Coles "Colossus" 40-ton mobile crane—the largest mobile crane in the world—owned by Tarslag Ltd.

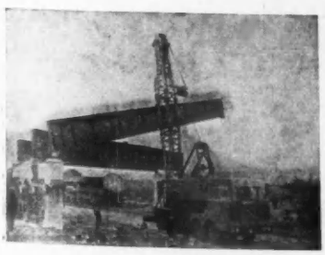
The job was carried out near Lynemouth



First stage of a big lift. The "Colossus" is seen unloading the three main bridge girders from the transporter which brought them to Woodhorn. Two of the girders weighed 22 tons, the other 29 tons.

Colliery in Northumberland and the bridge, which spans the main road between Newbiggin-by-the-Sea and Woodhorn, is to carry a double-track railway line from the new washing plant at Lynemouth Colliery to a main line connecting the other collieries.

The "Colossus" chosen for the job is the only fully mobile crane capable of handling such loads. During the 18 hours that the road was closed to traffic the three main girders and



The last of the three main girders of the Woodhorn bridge is lowered into position by the "Colossus". The precise control afforded by the Coles diesel-electric transmission system makes "pin-point" jobs such as these comparatively simple matter.

54 concrete decking joists were positioned. In addition six approach span girders weighing up to 6 tons were placed in position while the road was in full use.

The girders, fabricated by Dorman, Long & Co., Ltd., were brought to the site on a road transporter. All were lifted by the "Colossus" and positioned accurately on the bridge piers in single operations.

Consulting engineers are Maunsell, Posford & Pavry, Ltd., and the contractors are Holloway Bros. (London), Ltd.

NEW CRANES TO LIFT 25 TONS AT 10 foot RADIUS

3 Newcomers to Coles range of mobiles

DESIGNED to lift a load of 25 tons at 10 ft. radius and incorporating several new features, are three important additions to the Coles range of mobile cranes. They are the self-propelled, lorry-mounted and rail versions of a new model—the 2710.

Fitted with a 30 ft. strut jib of lattice construction, the cranes have all the well-proved Coles features including diesel-electric transmission, with separate motors for the hoist, derrick and slew motions, and, in the case of the rail and self-propelled versions, for travelling too. The standard 30 ft. jib can be extended to a maximum length of 80 ft., which is capable of lifting 1½ tons over a radius of 60 ft.

This form of transmission ensures smooth handling with precise control at all times. Electro-mechanical brakes act automatically on the three motions of slew, hoist and derrick, the last two of which also have automatic self-resetting limit switches.

POWER UNITS

On the rail and self-propelled cranes a choice of two power units is offered—a Ford petrol engine giving 64 b.h.p. at 2200 r.p.m. or a Perkins diesel giving 65 b.h.p. at the same r.p.m. The lorry-mounted crane is fitted only with a Perkins engine. For travelling, this model uses an A.E.C. diesel engine of 150 h.p. at 1800 r.p.m., giving it a maximum road speed of 27·3 m.p.h.

Mounted on a Coles 6×4 crane carrier chassis, the L.2710 has power-assisted steering, a five-speed gearbox (with one reverse), an auxiliary gearbox and air pressure brakes on all wheels. A 6-wheel drive chassis can be supplied for cross-country operation.

A new feature on this model is a removable counterweight—an important consideration for countries which limit the weight of vehicles using public roads. The weight of the L.2710 can be reduced by 4 tons when the counterweight is removed.

The rail crane has eight single flange steel-tyred wheels and air pressure shoe brakes on all of them. Optional equipment includes spring buffers and derailing beams. On the self-propelled model the Coles automatic reversing mechanism on the steering gear is provided to give "correct" steering no matter what the position of the driving cab in relation to the wheels. Power-assisted steering can be supplied as optional equipment.

SAFE LOAD INDICATOR

An optional item for all models is a visual and audible safe load indicator, which warns the operator of any tendency to lift an unsafe load. Fly jibs can also be supplied as well as a single hook for faster hoisting speeds with light loads. The enclosed operator's cabs have safety glass opening windows and can be fitted with a fan or a heater according to climatic conditions.

The skill and experience which go into all Coles cranes are "built in" to the new models. Backed by sound service facilities the Coles 2710 is a worthy addition to the range.

It's Coles again for Babcock & Wilcox

THE internationally famous engineering company of Babcock and Wilcox is at present using 50 Coles mobile cranes on projects in various parts of the world.

Recently they ordered a further two cranes—one for service in South Africa, the other for India. One of the many jobs on which Babcock and Wilcox, Ltd., are engaged at the moment is the extension of the Catalazzi Power Station in Turkey. The project is costing £3½ million and our picture shows a Coles S.1710 in action there.

"Mobile Handling in the Iron & Steel Industry"

Many of the largest iron and steel producers have already discovered the benefits to be gained by using mobile cranes in the mills. Coles cranes are fitted with grabs and magnets as well as hooks, making a vital contribution to the ever-increasing output of this important industry.

If you would like more information on the part Coles cranes can play in one of Britain's basic industries write for our new catalogue, which is full of information on this important subject.

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Aeroflex

ENERGY LIMITING CARTRIDGE FUSES TO CLASS P

This new range of Aeroflex Fuses (AD and FC type) Category 440 AC5 Class P - is fully interchangeable with the former patterns and is now supplied in all listed Fluvent Switch and Fusegear. They offer refinements in performance, primarily due to the following factors:-

TECHNICAL DATA

Publication CF2 deals extensively with the subject and affords interesting data. A copy will be forwarded gladly to enquirers and students.

These characteristics are extensively detailed in this new publication, CF2, which reproduces actual oscillograms obtained during ASTA tests.

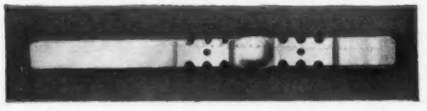
(1) The proved Breaking Capacity is raised from 33 to 46 K.A.

(2) The Energy Limiting is uniformly developed throughout the range.

(3) The fusing Factor is standardised at 1.25 throughout the range.

(4) The cartridge cases are ceramic instead of fibre.

(5) The end caps are fixed instead of being detachable as in the AF pattern, and re-wiring is normally carried out by returning blown cartridge fuse-links to the factory and not on site.



★ The latest types of Aeroflex fuse element as employed in the AD and FC type Energy Limiting Fuses.

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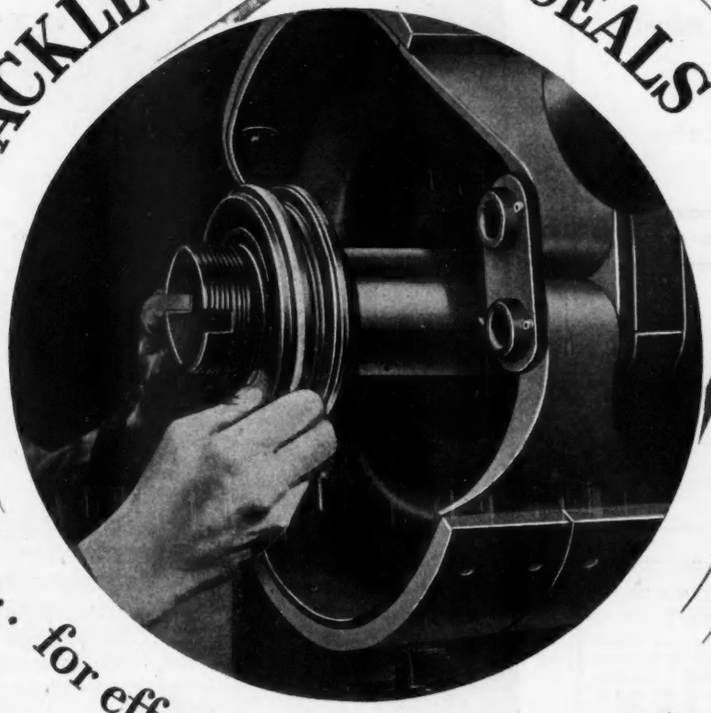
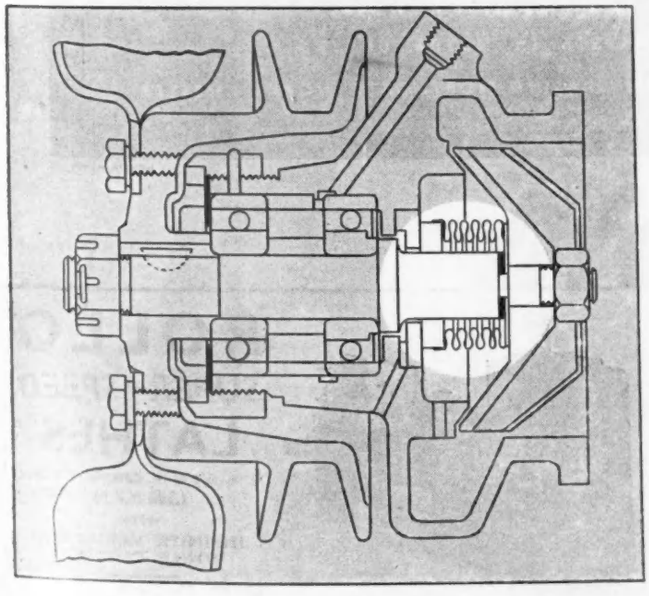
PACKLESS SHAFT SEALS



Photograph by courtesy of London Transport Executive

TEDDINGTON Shaft Seals are ideal for shafts running at speed. For example a 3½" dia. shaft running at 2000 R.P.M. in temperatures up to 300°F is quite normal. As peripheral speed of the rubbing surfaces is the deciding factor, they can be fitted to larger shafts running at lower speeds, or to smaller ones at high speeds. They will retain most liquids or vapours at pressures from 30-in. vacuum to 250 lbs. per sq. in., and are unaffected by continuous or intermittent running, or reversing.

... for effective sealing against most liquids and gases



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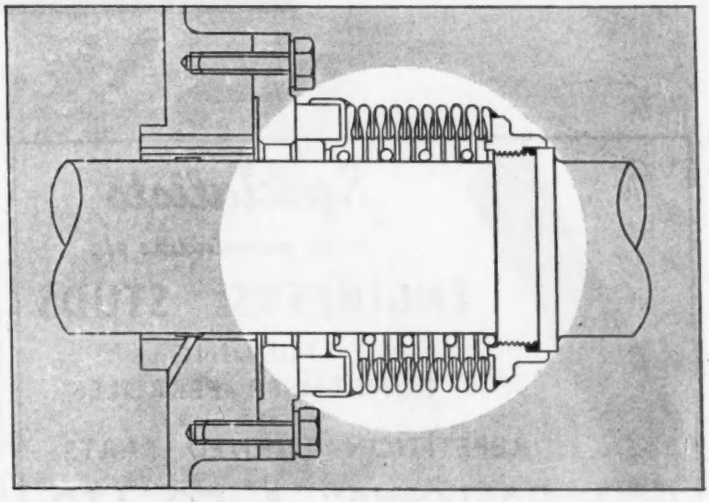

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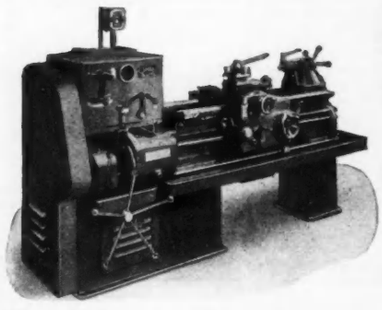

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SUPER SPEED
LATHES
7½ in. and 8½ in. CENTRE HEIGHT
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WITH
INFINITE VARIATION
WHILE CUTTING
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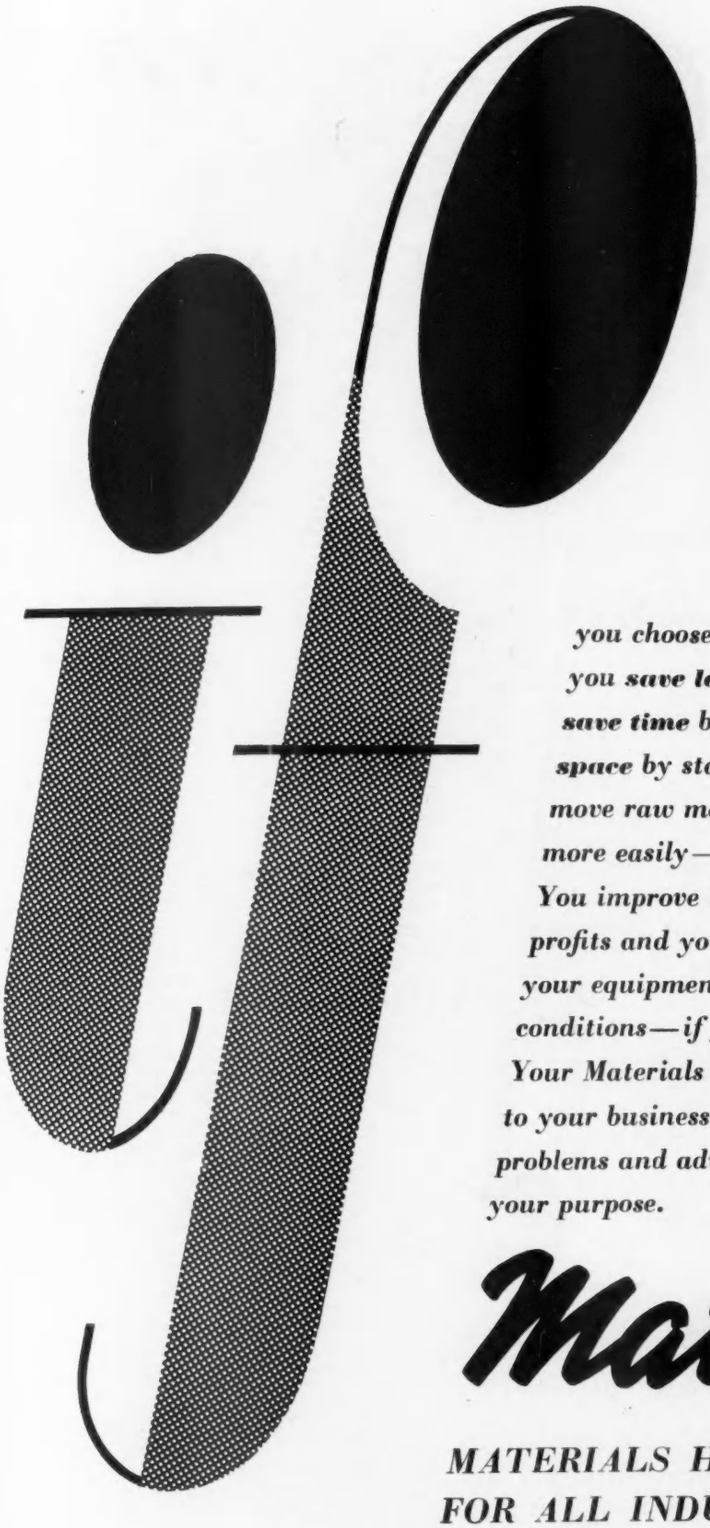

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Matling LTD

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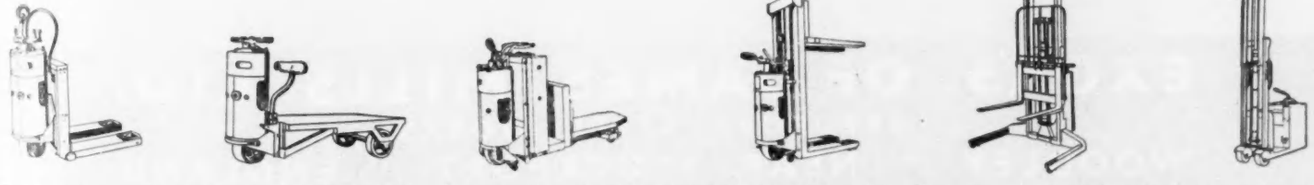

Head Office and Works: ***PARK LANE, FALLINGS PARK, WOLVERHAMPTON. Telephone: WOLVERHAMPTON 31295***

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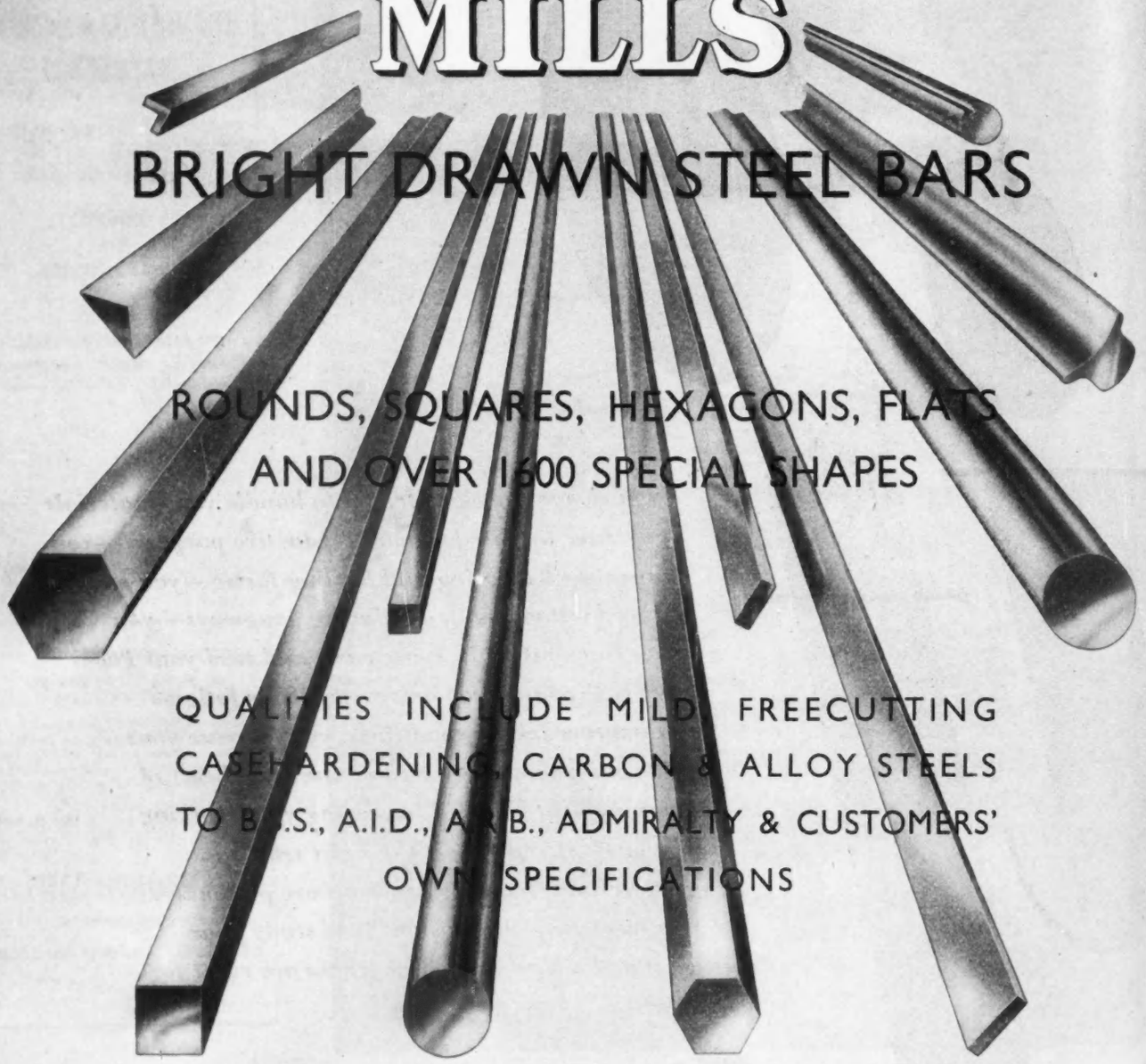

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QUALITIES INCLUDE MILD, FREECUTTING
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FLATS-SIZES UP TO 4"×3", 6"×2" AND 8"×1"

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SLUICE VALVES
for
Oil Tankers
and Oil Pipelines

always seat with absolute tightness since the spindle is extended to a footstep bearing in the bottom cleaning door thus ensuring accurate alignment of the gate.

with extra deep stuffing box.

with handwheel or with spindle connection as required.

with gas-tight gland if required.

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MAKERS OF THE BEST IN SLUICE VALVES

Head Office and Works :
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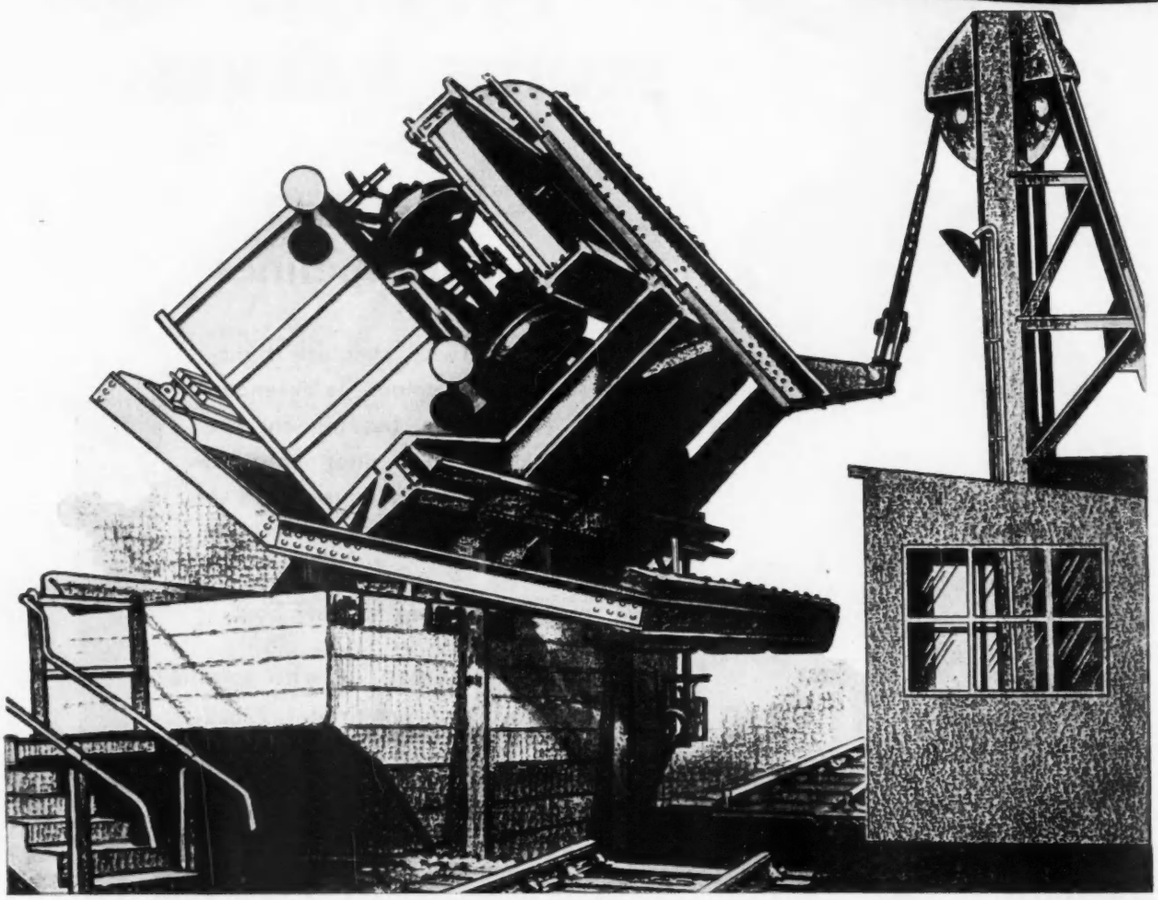
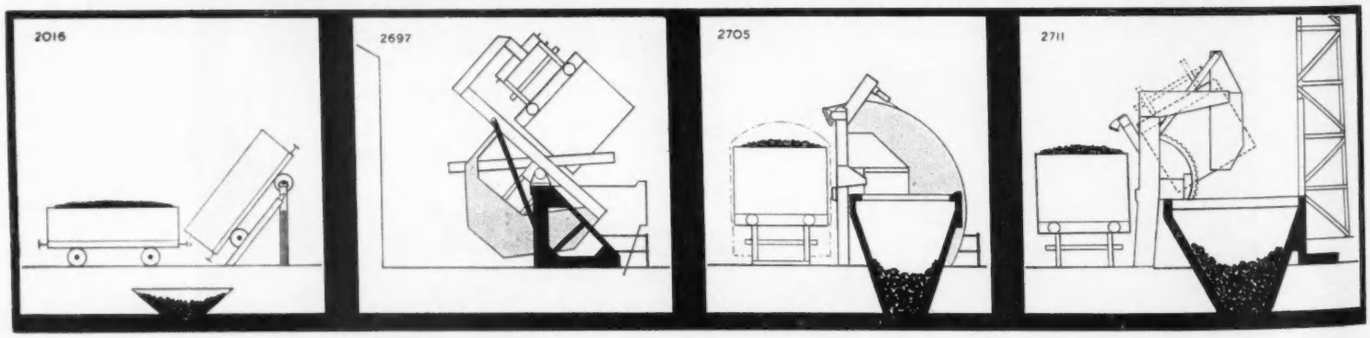
Wagon Tipplers by HENRY LEES & COMPANY LIMITED





In our range of wagon tipplers we continue to offer an unrivalled choice of machines to suit the varying needs of industry. Many years of experience in producing wagon Tipplers lie behind such new designs as are outlined in figures 2697, 2705 and 2711 above. We should welcome the opportunity to submit up-to-date particulars of suitable machines to meet customers' particular site conditions. All machines comply with the Railway Clearing House requirements.

2016 Geared ram type end door discharge tipper.
2697 Rope ram type side discharge tippler.
2705 Rope ring type side discharge tippler.
2711 Geared ring type side discharge tippler.

HENRY LEES & Co. LTD. ENGINEERS & CONTRACTORS, MOTHERWELL, SCOTLAND
PHONE: MOTHERWELL 1818-9 GRAMS "ROLTIP" MOTHERWELL

Removing more metal in a shorter time with less wheel wear . . .

A grinder running at constant speed under load will remove more metal in a shorter time and with less wheel wear than any machine which slows up under the efforts of the operator. That is why iron and steel foundries and other works where Hicycle grinders are installed are getting more work done per operator than is possible with any other type of tool. Only Hicycle grinders have this constant speed characteristic, and there is a full range of models from small die grinders to 8" heavy duty machines. Ask for a descriptive brochure on Hicycle grinders and other Hicycle production tools.

ECONOMISE WITH Hicycle GRINDERS

from the range of high frequency tools made by

Consolidated Pneumatic

MAKERS OF HIGH-CLASS ROCK DRILLS, AIR COMPRESSORS AND POWER TOOLS

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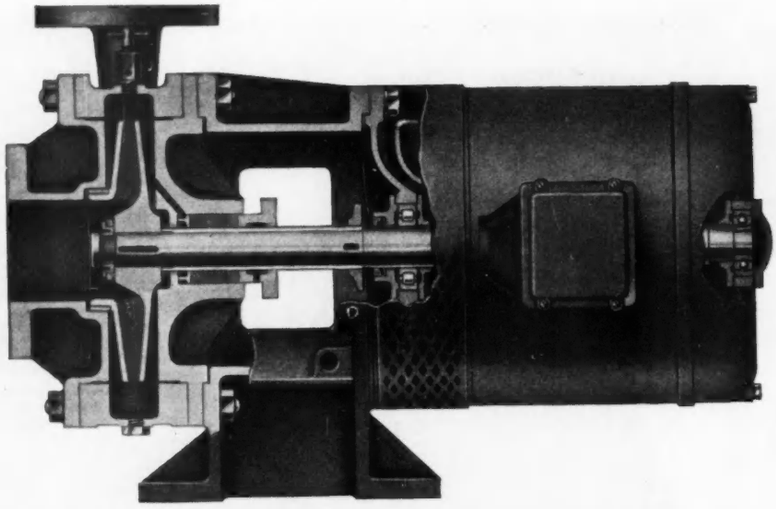
THE CONSOLIDATED PNEUMATIC TOOL COMPANY LTD., 232 DAWES ROAD, LONDON S.W.6



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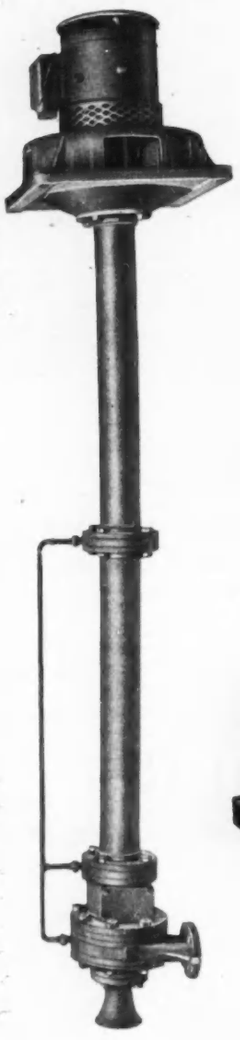

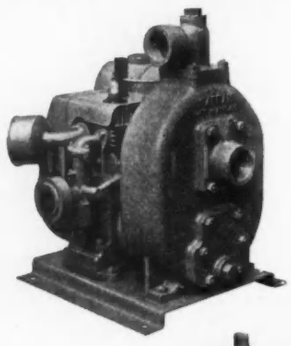

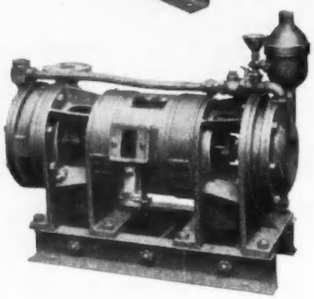

and adapted to their purposes by material specifications to suit the fluids handled, and by layout and drive to suit location and power available.

SAFRAN
REGISTERED TRADE MARK
PUMPS

UNISHAFT ELECTRIC PUMPS (Above)
Efficient pumping in its most compact form. Pump and motor mounted on one shaft and supported in the sturdy bulkhead mounting. In eight sizes from ¾in./1in. to 5in./6in. For duties up to 60,000 G.P.H.
There are also Unishaft Petrol and Diesel Engine Units in the range.

TRUNK PUMPS (Left)
With ground level motor and immersed pump. With single or multi-section shafting to suit depth of well, etc. Also available with automatic float operation for cellar draining and similar duties.
Deep Well pumps with Multistage units in various layouts to suit fluid and purpose.

AUTOMATIC SELF PRIMING PUMPS
Engine or motor driven as required on barrow or baseplate mounting. Suitable for handling dirty water containing small solids. 1½in. model for duties up to 3,480 G.P.H. 3in. model for duties up to 17,400 G.P.H.

SELF PRIMING PUMPS
Unishaft drive from central motor to main and air priming units. The continuously running air pump permits the main pump to work 'on snore.'

MULTISTAGE PUMPS (SELF PRIMING)
With this latest type of Safran Multistage pump, Self Priming can be offered without in any way impairing pumping efficiency. Pump internals can be dismantled without breaking pipelines. One gland only (low pressure) thus eliminating any high pressure gland trouble. Automatic balance of impellers. Seven sizes from 1in. to 5in./6in. for heads up to 800ft.

Descriptive literature and performance data on application.

SAUNDERS VALVE COMPANY LIMITED
SAFRAN PUMP DIVISION
CWMBRAN, MONMOUTHSHIRE WORKS: DRAYTON STREET, WOLVERHAMPTON

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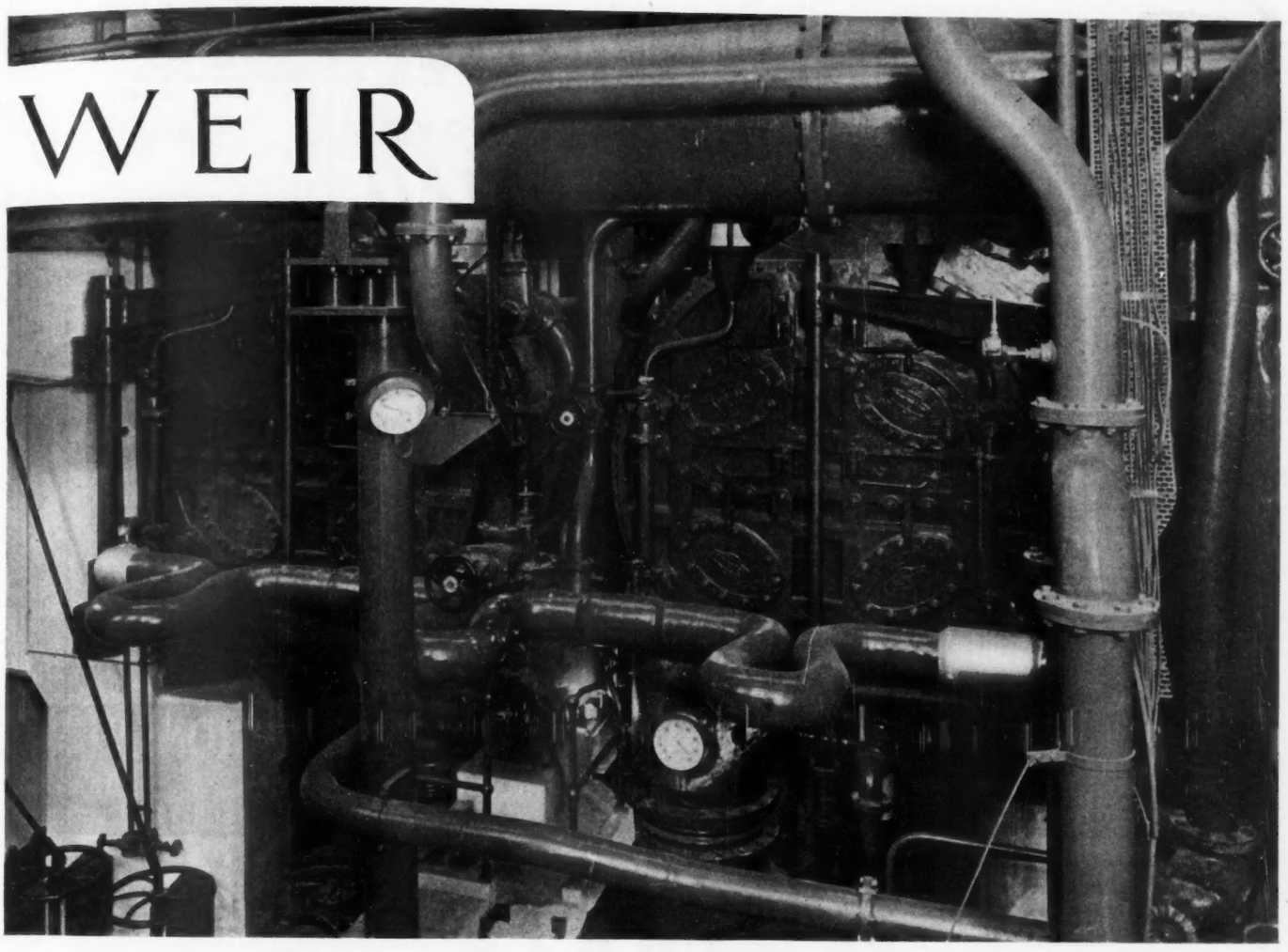

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Highest Vacuum
High Condensate Temperature
De-aerated Condensate

Weir Regenerative Condensers are made to our design and under our supervision by leading engineering firms. We welcome consultation on all questions relating to condensing, feed pumping and feed heating, in which we have unrivalled experience.

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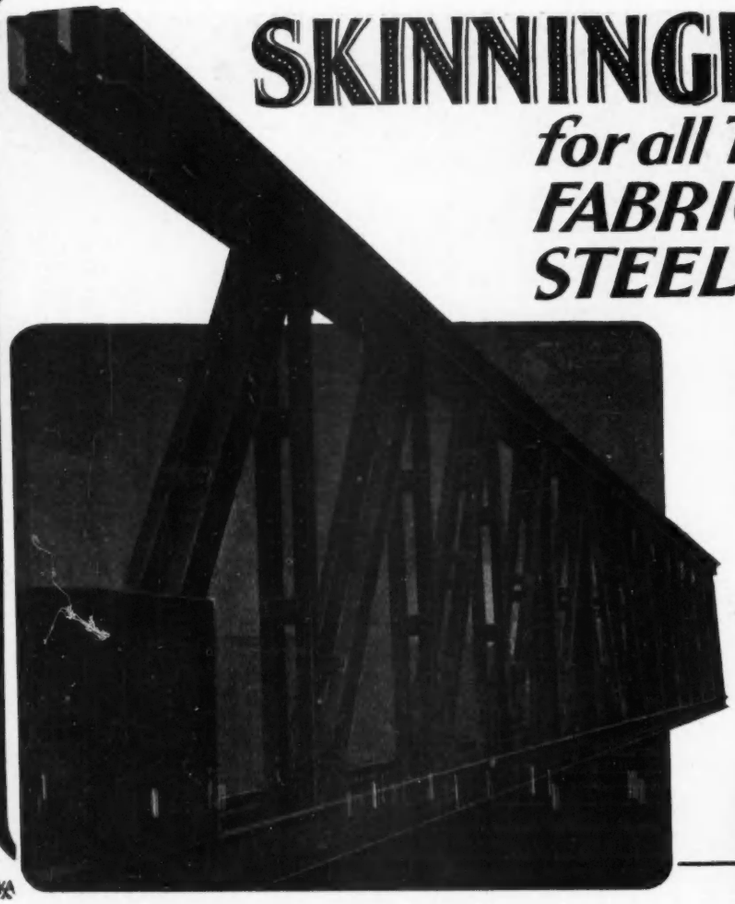

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Trial Assembly in our shops of a Lattice Girder for overhead Crane Track Weight: 29 Tons. 125' 0" clear span. 13' 6" deep.

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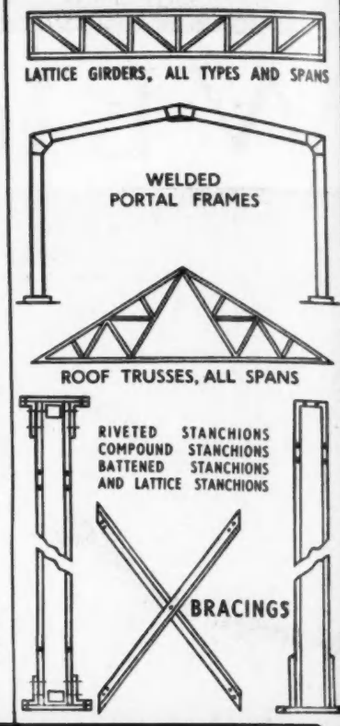

SKINNINGROVE IRON Co LTD
SALTBURN-BY-THE-SEA . . . . YORKS.
TELEPHONE: SALTBURN 194

FARRAR
AIR RECEIVERS

INSTALLED AT
VAUXHALL MOTORS LTD
LUTON - BEDS.

THESE PHOTOGRAPHS WERE KINDLY SUPPLIED BY MESSRS. VAUXHALL MOTORS LTD., TO WHOM OUR ACKNOWLEDGEMENTS AND THANKS ARE DUE FOR PERMISSION TO PUBLISH.

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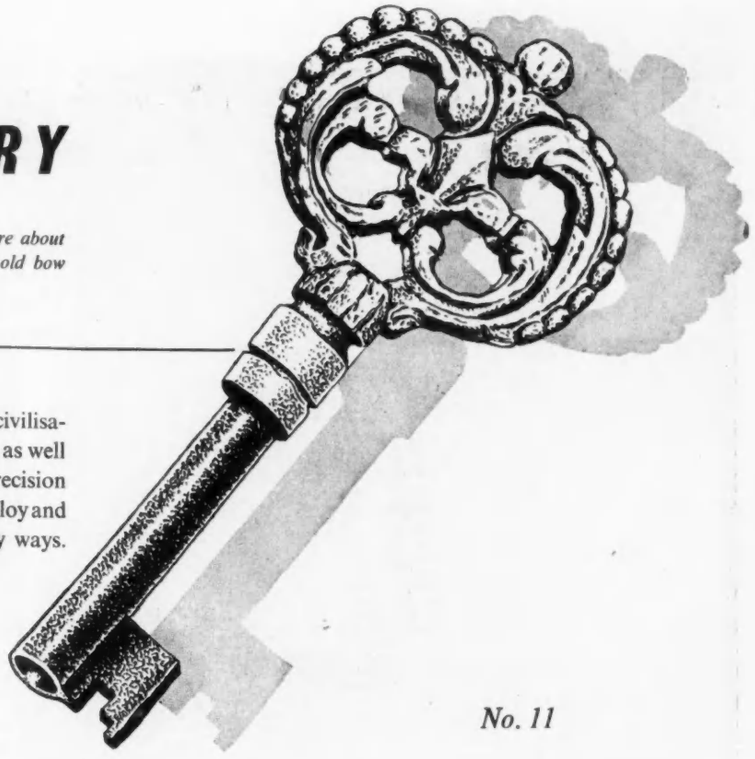
KEY TO INDUSTRY

Here is an early key, hand made by Sheffield craftsmen, somewhere about the third quarter of the 18th century. It was made to lock an old bow fronted Georgian chest-of-drawers, and is still in active use.



The development of steel made possible the growth of civilisation itself. For steel is the key to the good things of life as well as to the necessities; as essential to the maker of the precision watch as to the bridge-builder. Hallamshire high-grade Alloy and Carbon steels serve a multitude of industries in many ways.

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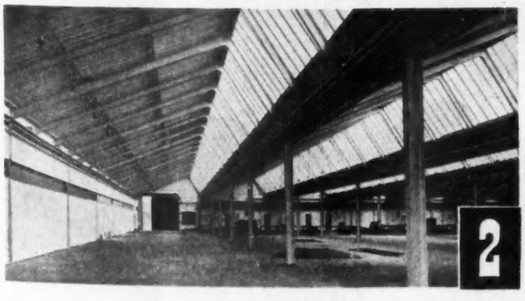

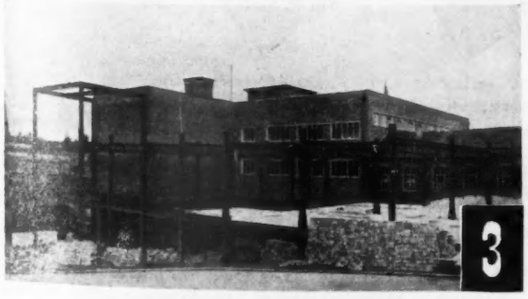

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ESTABLISHED 1850

STRUCTURAL STEELWORK
by
AUSTINS

1 New Stores Building for Messrs. Birlec Ltd., Furnace Manufacturers, Erdington, Birmingham.

2 Interior view of factory for Messrs. Brook Motors Ltd., Barnsley.

3 Extension to factory for Messrs. F. E. Fox & Son Ltd., Biscuit Manufacturers, Batley. Architects: Smith & Curry, Heckmondwike.

James Austin & Sons (Dewsbury) Ltd
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Associated Companies:
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SPIRAX SARCO

If you must lift things-

—Condensate, for example: it's just as well to make sure before you start that you have enough power to do the job.

A steam pressure of 1 psi will support a water column 2ft. 3in. high. To lift condensate, say, 18ft. requires a steam pressure of 9 psi. But this pressure is needed *at the point of lift*, and there may not be the required steam pressure on condensate being discharged through a steam trap.

Plant fitted with temperature controllers, for example, is not suitable for trap-lifting methods; when the controller throttles the steam supply, there won't be enough pressure to lift, waterlogging will take place and water-hammer will follow when the controller opens again.

Of the two methods of raising hot condensate, pumping is, in general, by far the best. The condensate is allowed to gravitate to a convenient vented receiver (serving several units if need be) fitted with a pump or lifting trap.

The 'Ogden' is a reliable automatic pump operated by steam or compressed air. *Simple though it is, its correct installation for proper condensate lifting requires precision.*

The pump method of lifting condensate, besides avoiding waterhammer, has another important advantage. If the unit is allowed to drain by gravity, any air present in the steam space can be quickly purged when the plant is started. A unit with a condensate lift is water-sealed, and air cannot be removed. Heat transfer is impaired, and output reduced. *May we tell you more?*

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Phone: Cheltenham 5175-76 *Grams: Spirax Cheltenham*
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REQUEST SLIP

To SPIRAX-SARCO LTD., CHELTENHAM, Glos. *Please send information about lifting condensate*
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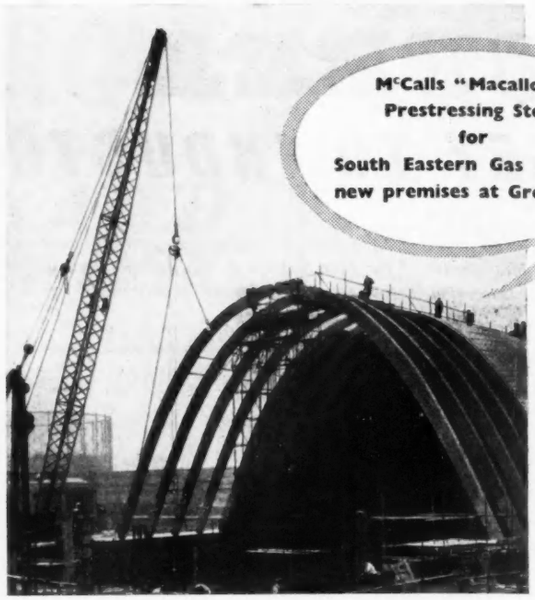

Precast Arch-Ribs — Lee-McCall post-tensioned units

The photograph shows a new sulphate of ammonia store and bagging house for South Eastern Gas Board at Phoenix Wharf, Greenwich.

Designed by The Central Construction Department of the South Eastern Gas Board in conjunction with "Twisteel" Reinforcement Limited.

Contractors: Demolition & Construction Co., Limited.
Precast End Blocks: Liverpool Artificial Stone Company.
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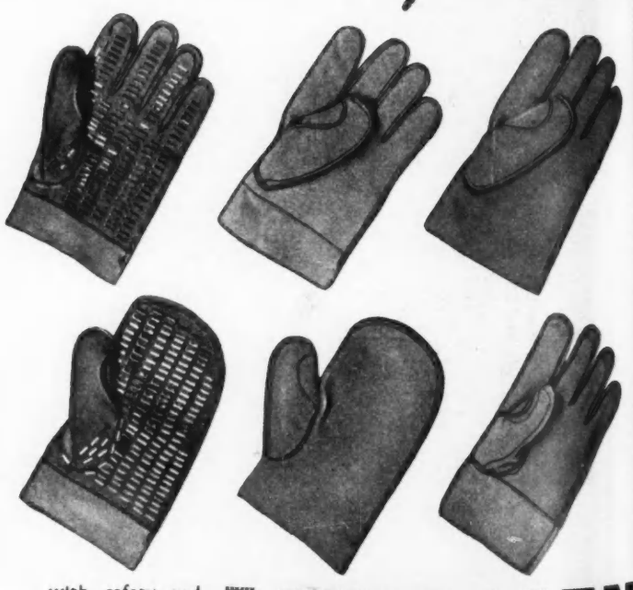
Phone: ROTHERHAM 2076 (P.B. EX 8 Lines) LONDON OFFICE: 8-10 GROSVENOR GARDENS S.W.1 Tel: Sloane 0431

PC.28

Hand in Glove...



. . . with safety and reliability, Hillman works gloves are made in 23 styles and special leathers, and are favoured by every user throughout the heavy industries.

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also APRONS, HAND LEATHERS
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J. & A. HILLMAN LTD., DUDLEY, WORCS.
OIL SEALS BELTINGS & ALL CLASSES OF LEATHER : LEATHERWORK & FABRIC FOR INDUSTRIAL USE

Made by James Neill & Co (Sheffield) Ltd., and obtainable from all tool distributors UHJ

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BRYSOL

Quick-Action RUST SOLVENT

Where force fails to free rust-cemented nuts, bolts and other metal parts, BRYSOL succeeds! This penetrating oil fluid quickly breaks down the heaviest rust formation.

Sold in tins of all sizes 4 oz. to 1 gal. by leading Ironmongers and Stores.

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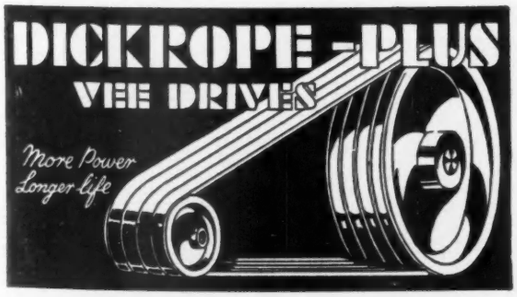
BRYCE WEIR LTD.
1 BRYLEX PAINT WORKS, WATFORD, HERTS.



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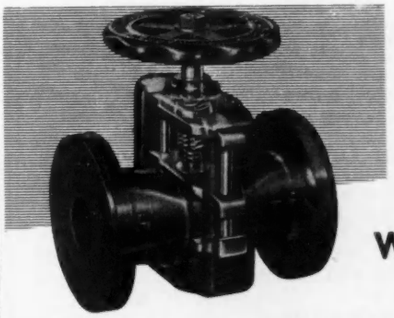
Agencies throughout the World



Specified for the most Arduous Duties . . . for all services with

WARREN-MORRISON PINCH VALVES

Straight-through rubber-lined W-M pinch valves have all the advantages of cleanliness, easy maintenance and smooth operation, however difficult the duty. Corrosives and abrasives, liquid, powder or gas, are efficiently handled by these valves which have only one part liable to be worn after long service—the easily replaceable rubber tube. Until this wears out W-M pinch valves CANNOT LEAK. All W.M. valves may be air-operated for remote or automatic control.

Write, or telephone WHitehall 9095, for further details

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Classified Advertisements continued from Page 7

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An Estimating/Planning Engineer is required for interesting work on electro-mechanical instruments in the Instrument division. The work includes the assessment of machining, assembly and tool times in conjunction with the laying out of process schedules. Pension Scheme, etc.—Apply: LOUIS NEWMARK LTD., PREFECT WORKS, PURLEY WAY, CROYDON, SURREY. J 852

CHEMICAL ENGINEERING COMPANY in Westminster district has a vacancy for a **TECHNICAL AND SALES ENGINEER.** Qualifications are: age about 25-30, B.Sc., standard, good knowledge physics, heat exchange essential and chemistry desirable. Understanding of general office procedure an advantage. The position offers an excellent opportunity for a man having these qualifications, coupled with a keen business outlook Write stating fullest possible particulars, including age, qualifications and salary required to BOX J 854, Offices of ENGINEERING.

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Graduates required for the following permanent and pensionable posts. Applicants should be exempt from or have completed National Service.

1. **INSTRUMENT ENGINEERS** with good experience in the chemical or oil industries.

2. **PHYSICISTS AND CHEMISTS** with ability and interest in the development of special instrumentation and pick-off devices.

3. **CHEMICAL ENGINEERS** interested in the control of plant.

4. **MATHEMATICIAN OR PHYSICIST** with honours degree to be responsible for the programming of digital computers handling engineering problems.

Write for application form, marking envelope "D.4," to :—

PERSONNEL MANAGER,
METROPOLITAN-VICKERS CO., LTD.,
TRAFFORD PARK, MANCHESTER 17.

J 847

MERZ AND MCLELLAN require a **MECHANICAL ENGINEER** for their power station department at Esher. Candidates must be corporate members of one of the major engineering institutions and have sound knowledge of design and construction of modern steam power plant including ancillary equipment, buildings and general site works.—Apply in writing to MELBURN, ESHER, SURREY. J 855

Large Tannery in Lancashire requires **ENGINEER TO TAKE CHARGE OF MAINTENANCE DEPARTMENT** (80-100 men) and of development planning. Must have sound knowledge of steam raising, electricity and building. Applicants should be between 30 and 45 years of age, with grammar school education and A.M.I.Mech.E. or similar qualifications.—Replies, with full details of education, experience and salary required, to BOX J 853, Offices of ENGINEERING.

MERZ AND MCLELLAN have vacancies in their Esher Office for **MECHANICAL ENGINEERING DRAUGHTSMEN.** Applicants should be experienced in plant layout work preferably, but not essentially, in connection with steam power stations. Salaries will be fully appropriate to applicants' experience starting at about £680 per annum at 25 years. Excellent working conditions. Five-day week. Pension Scheme. Canteen.—Apply in writing to MERZ AND MCLELLAN, MILBURN, ESHER, SURREY. J 856

FACTORY MANAGER FOR WEST BERLIN required by International Company. Must be skilled mechanical engineer with experience applicable to mass production of light metal goods to close limits, and able to speak English and German. Would be required to move permanently to West Berlin after training in England. Age 30-45. Salary would not be less than £2000, paid in Berlin.—BOX J 799, Offices of ENGINEERING.

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AN ENGINEER OF OUTSTANDING PERSONALITY is required to fill a vacancy on the staff of a well-known industrial company. Age 28-35, used to responsibility and working on own initiative. A salary up to £1500 is offered with outstanding prospects of advancement. University Degree, practical workshop training and experience essential. Full details of qualifications and posts held in confidence to BOX J 818, Offices of ENGINEERING.

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A PROMINENT

chemical manufacturer, operating in the East London area, has vacancies for men experienced in the layout and detailing of chemical plant installations, including pressure vessels, pipework, steelwork, and associated mechanical items.

THE WORK

is of a varied nature, covering new projects in the main in which speed is an essential factor.

THE COMPANY

is just embarking on a substantial scheme of expansion involving the development of a large new factory site.

APPLICANTS

should have a good mechanical background with technical qualifications to Ordinary National Certificate level or higher.

THE SALARIES

paid will be in accordance with A.E.S.D. rates or better.

THE POSTS

are permanent and pensionable with good working conditions, five-day week, canteen and sports facilities.

APPLY

initially in writing, giving full details of training and career, age, etc., to BOX J 831, Offices of ENGINEERING.

DETAILING DRAUGHTSMEN with some mechanical engineering experience required for unusually interesting range of development work. Excellent scope in small, expanding D.O. for enthusiastic and enterprising men.—RHODEN PARTNERS, 51, NORTH ROW, W.1. MAYfair 6248. J 815

METAL ENGINEER, inventive mind essential, wanted by manufacturers, bedsteads and bedding. Initiate and develop contemplated production steel and chrome steel sleep and domestic equipment. Full written details to MANAGING DIRECTOR, SPIRALYNX (1933) LTD., ROWLAND STREET, LONDON, E.1. J 823

BRITISH PETROLEUM COMPANY, LIMITED, has vacancy for **MECHANICAL ENGINEER** in the MIDDLE EAST. Applicants, aged 25-28, must have served General Engineering Apprenticeship and possess Higher National Certificate, with at least 3 years' subsequent experience of maintenance work in an Oil Refinery, Chemical Works or Power Station, followed by 2 years' experience of planning, co-ordination and direction of maintenance work. Attractive salary plus generous allowance in local currency, free passages out and home, free medical attention, good leave, arrangements, Pension Scheme, kit allowance, air-conditioned accommodation.—Write, giving full details of qualifications and experience, quoting F.506, to BOX 1673, c/o 191, GRESHAM HOUSE, E.C.2. J 801

Opportunities in
LOW TEMPERATURE ENGINEERING.
Applications are invited for appointment as
DEVELOPMENT ENGINEERS
to undertake interesting projects, involving thermodynamics, heat transfer distillation, and covering the technical design and operation of plants. The projects are concerned with the production and distribution of oxygen, nitrogen and argon as gases or liquids.

Applicants should hold an Honours Degree.

For people joining the Company from outside the North London area, it is of interest that the Works is within easy travelling distance of North London residential areas, verging on the Green Belt of Middlesex and Hertfordshire, and on Epping Forest. FULL ASSISTANCE TOWARD THE PURCHASE OF HOUSES WILL BE GIVEN TO SELECTED APPLICANTS AND REMOVAL AND LEGAL EXPENSES PAID.

Applications, giving fullest possible information of qualifications and experience to :—

The Personnel Manager,
BRITISH OXYGEN ENGINEERING, LTD.,
ANGEL ROAD, UPPER EDMONTON,
LONDON, N.18. J 846

BRITISH PETROLEUM COMPANY LIMITED has a vacancy in the MIDDLE EAST for a **PLANNING ENGINEER** to assist in preparation of detailed work breakdowns of refinery plants, work load estimations and drawing up of work schedules for large scale maintenance work of all types. Applicants should possess Higher National Certificate or Associate Membership of Professional Institution and have served five-year apprenticeship or have minimum of 2-3 years' works experience with further Drawing Office experience. Preference will be given to applicants with 2 or more years' experience in Planning organisation of large industrial concern. Age limit 35. Attractive salary plus generous allowance in local currency, air-conditioned accommodation, free passages, kit allowance, free medical attention, good leave arrangements, Pension Scheme.—Write, giving full particulars, quoting F.501, to BOX 1687, c/o 191, GRESHAM HOUSE, E.C.2. J 803

The Soil Mechanics Department
of
RICHARD COSTAIN LTD.,
Building and Civil Engineering Contractors,
has a vacancy for a

SOILS ENGINEER.

B.Sc.(Eng.) degree essential. D.I.C. or M.Sc.(Soil Mechanics) an advantage.

Recent experience in Soil Mechanics laboratory preferable.

This is a permanent and pensionable appointment, which would suit a young recently qualified engineer, who is able to carry out routine tests and willing to improvise equipment and technique if need arises.

Salary according to experience. Office hours, 9-5.30 p.m., no Saturdays. Good canteen and Sports Club facilities.—Apply giving full details of experience to :—

CHIEF PERSONNEL OFFICER,
RICHARD COSTAIN LTD.,
111, WESTMINSTER BRIDGE ROAD,
LONDON, S.E.1. J 788

ENGINEERING ASSISTANT.—Experience : apprenticeship with Structural Engineers. Qualification, B.N.C. standard or equivalent and capable of steelwork design.

Please apply to SIR BRUCE WHITE WOLFE BARRY & PARTNERS, 1, LYGON PLACE, S.W.1. SLO. 0431. J 782

Major Oil Company in Middle East require **TWO CONSTRUCTION ENGINEERS,** one with Oilfields and the other with Refinery experience. The Engineers appointed will be responsible for the overall planning and execution of all construction work including plant erection, roads, utilities, housing, etc., in the respective areas. Applicants, who should preferably be between 35 and 45 years of age, should be corporate members of a recognised engineering institution, or have a degree in Mechanical or Civil Engineering. Proved organising ability on major constructional projects is essential with not less than 10 years' practical experience in this field. Most attractive salaries payable and married accommodation available shortly with family passages.—Apply with brief particulars in first instance to BOX E.G.491, c/o 191, GRESHAM HOUSE, E.C.2. J 784

PRODUCTION ASSISTANT, 23-35, B.Sc. Mech. Eng., Phys. or Glass Tech., required to assist Chief Glass Technologist. Duties will include liaison between laboratory and factory, and advice on mechanical and glass problems. The post offers considerable prospects to a practical man with initiative and ambition.

Apply with details of qualifications, experience and salary required, to W. J. YEOMANS, PERSONNEL MANAGER, BRIMAR VALVE WORKS, FOOTSCRAY, SIDCUP, KENT. J 789

GRADUATES up to age 30 who want an interesting and satisfying career in an industry where hard work and new ideas are appreciated and rewarded are invited to apply for the posts of **DEVELOPMENT ENGINEER, CHEMIST OR PHYSICIST** to the under-mentioned box number. The salary range is £750 at 25 to £1350 at 32, with considerable scope for further financial advancement for men who contribute to the progress and prosperity of the Company. The Company's products are well established in world-wide markets and, to meet increasing needs in the export market in particular, new plant is being developed rapidly large sums are available for development work and the Company urgently needs the technical staff to see these new projects through. All applications, which will be treated in the strictest confidence, should give details of age, education and any previous experience.—BOX 835, c/o WHITES LTD., 72/78, FLEET STREET, E.C.4. J 768

ESSO PETROLEUM COMPANY, LIMITED, has a vacancy for a **DRAUGHTSMAN,** for work associated with Technical Sales Department. It is desirable that candidates should have a knowledge of small diameter pipe work and an aptitude for producing technical illustrations would be an advantage. Salary will be according to qualifications, and candidates should reply in writing giving full details of career to date, to the PERSONNEL MANAGER, ESSO PETROLEUM CO. LTD., 16, CHARLES II STREET, HAYMARKET, S.W.1. J 772

DEPUTY CHIEF JIG AND TOOL DESIGNER required with experience of the design of high-class precision tools as applicable to the production of small to medium class mechanical engineering products. This vacancy offers excellent opportunities and a good salary will be paid to the selected candidate. London area.—Please reply, giving full details, to BOX J 758, Offices of ENGINEERING.

SENIOR TOOL DESIGN DRAUGHTSMEN

A large and well-established engineering company located in the Eastern suburbs of London require press tool and jig and tool senior design draughtsmen. Applicants should have served a good engineering apprenticeship followed by drawing and design experience of high-class precision tools in connection with the Light Electro-Mechanical Engineering fields. Well-equipped drawing office. Salary up to £950 per annum. Staff superannuation and insurance scheme available.—Please reply, giving full details of experience, to BOX J 759, Offices of ENGINEERING.

FURNACE ENGINEER. Applications are invited from suitably qualified Engineers who have a wide knowledge of installation and operation of large industrial furnaces. The man appointed will be responsible for a complete installation and his ability to organise a large labour force effectively is an essential qualification.—Please reply to PRIEST FURNACES LIMITED, LONGLANDS, MIDDLESBROUGH, YORKS. J 838

BRITISH PETROLEUM COMPANY has a Vacancy for an **ENGINEERING ESTIMATOR** for work in London, with occasional visits abroad. Age 30-35. Mechanical or Civil Engineering degree or equivalent. Applicants should also have served an engineering apprenticeship and had experience in estimating major projects for large engineering organisation. Salary according to age, qualifications and experience.—Applicants should write, stating age, qualifications, etc., quoting H.3620, to BOX 8447, c/o 191, GRESHAM HOUSE, E.C.2. J 849

ELECTRONICS ENGINEER

A vacancy exists in Johannesburg in the Geophysical Section of the Geological Department of the Anglo American Corporation of South Africa Limited for an Electronics Engineer at a salary between £1200/£1400 per annum according to qualifications.

The successful applicant, under the guidance of, and in co-operation with, the senior Geophysical staff, will be required to undertake research upon and design and construction of electronic equipment concerned with improved and new instrumentation or methods of geophysical exploration and interpretation.

Applicants must have experience in the design and construction of electronic equipment (preferably not limited to communications) and should have a degree in Physics or Electrical or Electronic Engineering, or equivalent qualifications, failing which a considerable record of suitable experience would be considered.

Applications in writing, giving details of age, marital status, experience and qualifications, should be addressed to :—

THE APPOINTMENTS OFFICER,
ANGLO AMERICAN CORPORATION OF SOUTH AFRICA, LIMITED,
11, OLD JEWRY,
LONDON, E.C.2. J 850

DRAUGHTSMAN FOR MAINTENANCE AND DEVELOPMENT OF SEAMLESS STEEL TUBE PLANT. Heavy engineering and Hydraulic experience desirable. Five-day week. Permanent pensionable position to suitable applicant. Special rate will be paid to man of high ability and qualifications.—Write, stating full particulars, to the CHIEF ENGINEER, STEWARTS & LLOYDS, LIMITED, BROMFORD TUBE WORKS, WHEELWRIGHT ROAD, ERDINGTON, BIRMINGHAM, 24. J 830

ENGINEER with sound technical knowledge of industrial dust collection problems and previous commercial experience for well-known firm in London area. Permanent position, good salary, five-day week, pension scheme.—Write BOX J 834, Offices of ENGINEERING.

TECHNICAL ASSISTANT TO PRODUCTION ENGINEER required, age 24/30. Essential qualifications are apprenticeship in General Mechanical Engineering, H.N.C. and Jig and Tool Design experience. The appointment offers good prospects. Contributory pension scheme, good canteen facilities. Housing accommodation may be available March/April, 1956.—Apply, stating age, qualifications and salary required, to WORKS MANAGER, THE BRITISH STEEL PILING CO., LTD., CLAYDON, NR. IPSWICH, SUFFOLK. J 829

ENGINEER with sound technical knowledge of air filtration problems and previous commercial experience for well-known firm in London area. Permanent position, good salary, five-day week, pension scheme.—Write BOX J 833, Offices of ENGINEERING.

Required for large, old-established, mass production precision Engineering Works in East Midlands, **EXPERIENCED TIME SERVED ENGINEER** to assume control in due course of up-to-date GRINDING DEPARTMENT on the shop floor.

The position is suitable for an engineer about 40 years of age with good practical and some technical ability, and who is prepared to keep abreast of modern development. Every assistance and encouragement will be afforded the successful applicant by existing staff.

The position is pensionable and a suitable engineer can be assured of a permanent and interesting position.

Reply, stating age, particulars of experience, qualifications and salary required. Replies will be treated in confidence.—BOX J 836, Offices of ENGINEERING.

BRITISH OXYGEN GASES LIMITED require a **SENIOR MECHANICAL DRAUGHTSMAN** for work in the Cricklewood area. Applicants should preferably have had experience of plant layout and possess a good engineering background. A very good salary is offered. Canteen and Pension Fund facilities available.—Reply, stating full details, to PERSONNEL DEPARTMENT, BRITISH OXYGEN GASES LIMITED, BRIDGEWATER HOUSE, CLEVELAND ROW, ST. JAMES'S, LONDON, S.W.1. J 795

A. BOAKE, ROBERTS & COMPANY LTD., CHEMICAL MANUFACTURERS, CARPENTERS ROAD, LONDON, E.15, require **WORK STUDY ENGINEERS** to Install Method, Study and Work Measurement Schemes in their London factories. Candidates should have had previous experience in a process industry, and an engineering qualification would be an advantage. Salary will be commensurate with age, experience and qualifications.—Applications should be made, in writing, to the WORKS DIRECTOR. J 827

AMBITIOUS ENGINEERS.

IMPERIAL CHEMICAL INDUSTRIES LIMITED,
ALKALI DIVISION,
WINNINGTON, NORTHWICH,
CHESHIRE,

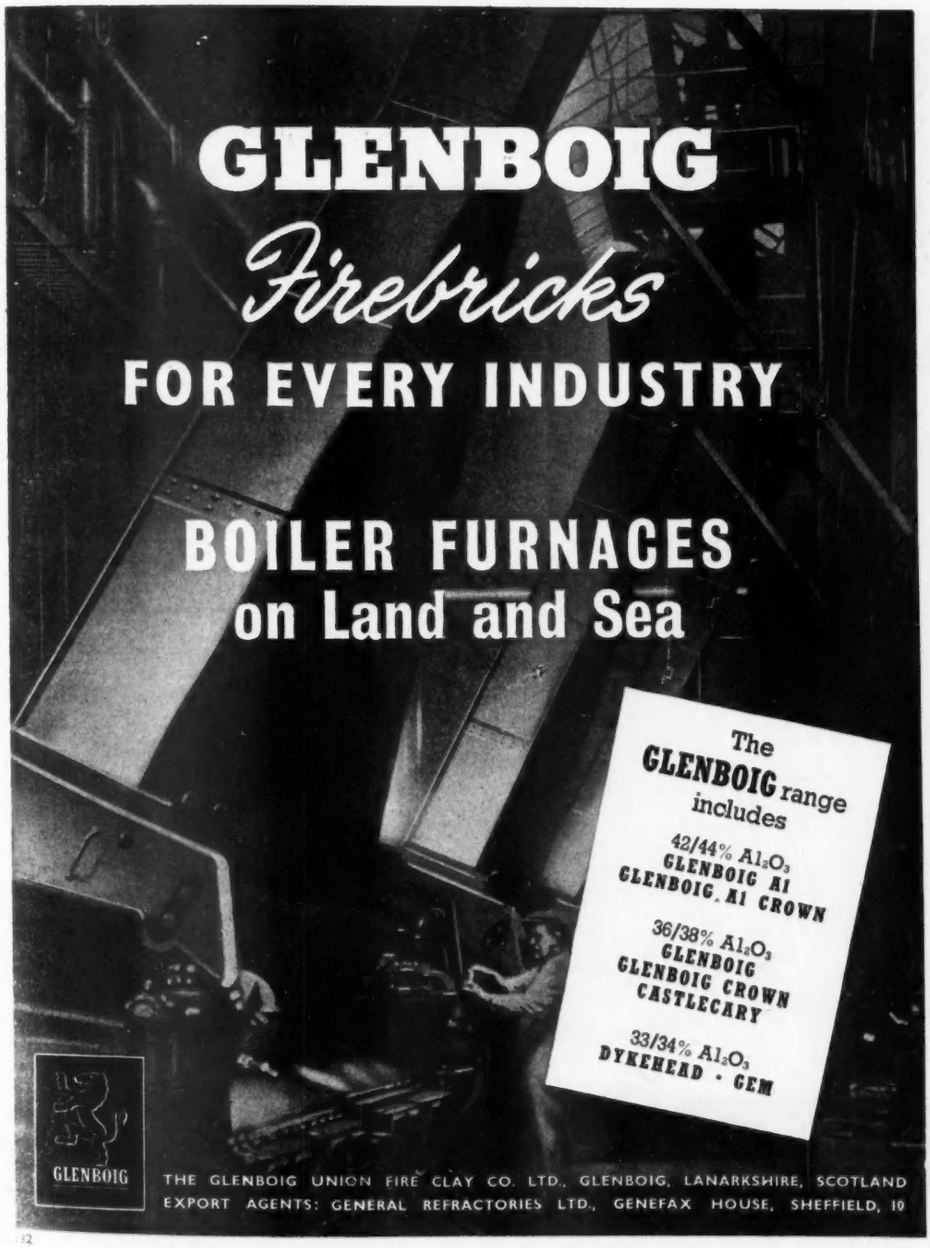
have vacancies for ambitious Engineers at their headquarters and works in mid-Cheshire. Candidates should be aged 25/40 and possess a good degree in mechanical or chemical engineering.

They will be engaged upon investigation and development work involving a thorough knowledge of mechanical engineering. The work will be in connection with new plants and processes for the manufacture of a number of special products including Polythene. In much of the work no experience in chemical plant work is required.

The work is interesting and varied and will involve both theoretical and practical treatment; the man with initiative and with ability to think of and apply new ideas will have excellent prospects.

Commencing salaries will depend on qualifications and experience. The appointments are permanent and carry membership of the Staff Pension Fund, also eligibility for Employees' Profit-Sharing Scheme. The Company can give help to married men to assist them with house purchase and the expenses of their removal.

Apply to STAFF MANAGER—quoting Ref. GES/DEV—for application form. J 798



Consulting Engineers, Westminster, require **SENIOR ASSISTANT** with considerable experience in road and bridge design. High salary and good prospects for suitable applicant. Write in confidence stating age, qualifications and full details of experience.—BOX J 769 Offices of ENGINEERING.

CIVIL ENGINEERING DRAUGHTSMAN experienced in road and bridge work required by Consulting Engineers, Westminster. High salary and good prospects. Write stating age and details of experience—BOX J 770, Offices of ENGINEERING.

TECHNICAL ASSISTANT TO BRICKWORKS PRODUCTION ENGINEER required, age 24/30. A recognised qualification in General Mechanical Engineering, and some drawing office experience essential. A knowledge of electrical plant, high speed diesel engines, and building construction would be an advantage. Person chosen will be responsible, under the Production Engineer, for planning, installation operation and maintenance of all mechanical and electrical plant, excavators, kilns, etc. Permanent appointment with good prospects, and opportunity of obtaining a wide knowledge of Fletton Brick Manufacture. Pension scheme. Assistance in obtaining house if required. Apply stating age, qualifications and salary required, to the MANAGING DIRECTOR, WHITTLESEA CENTRAL BRICK CO. LTD., WHITTLESEA, PETERBOROUGH, NORTHAMPTONSHIRE. J 771

A SENIOR INVESTIGATOR is required to direct the activities of a group of people engaged in applied research into metallurgical problems connected with the rolling, extrusion and forging of aluminium alloys. Familiarity with works processes and some research experience would be a decided advantage. The salary will be attractive and in accordance with age and experience. A pensions scheme is in operation.—Apply to: THE DIRECTOR OF RESEARCH, ALUMINIUM LABORATORIES LIMITED, BANBURY, OXON. J 774

DEVELOPMENT ENGINEER required to be responsible for advanced projects involving the development of electrical machines for special applications. Engineers interested in high-frequency alternators, machine voltage and speed control systems, and improvements in mechanical and electrical design, are invited to apply. Applicants should possess an Engineering Degree or H.N.C. and those with previous design or development experience will receive preference. The work calls for a first-class man capable of working without detailed supervision, who is able to use initiative and imagination. Conditions of service include generous non-contributory superannuation scheme, and first-class social and recreational facilities.—Please apply to the CHIEF PERSONNEL OFFICER, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS. J 797

JUNIOR ENGINEER required for London Consulting Engineers specialising in industrial oil and coal power plants. Age 25/32. Salary, £700-£800, subject to qualifications and experience. Permanent post with good prospects.—BOX J 804, Offices of ENGINEERING.

ESSO PETROLEUM COMPANY, LIMITED, require **ASSISTANT CIVIL ENGINEERS** for resident staff on construction work in the Bristol area.

Applicants should have passed Sections I and II of the Institution of Civil Engineers examination or hold an exempting qualification. They should have at least two years' site experience on works including some of the following: earthworks, reinforced concrete works, foundations, roads, steelwork, pipe work, building construction.

Applications should be in writing, giving brief details of career and stating salary required, addressed to PERSONNEL MANAGER, ESSO PETROLEUM CO., LTD., 16, CHARLES II STREET, HAYMARKET, S.W.1. J 762

A BRITISH COMPANY handling world-wide agencies for leading manufacturers of all types of machinery requires **MECHANICAL ENGINEER** for London Office. Preferably qualified with some commercial experience and under 30 years.—Write BOX "DE/141," c/o 95, BISHOPSGATE, E.C.2. J 851

ASSISTANT ENGINEER required for Services Department of a large Chemical Manufacturing Company in South Birmingham district. Preference will be given to a man qualified and experienced in applications of steam, water and compressed air services in factories, who is able to prepare schemes and reports, design and supervise installation, and, generally supervise the economic operation of factory services. A good salary will be paid to the right man —Please reply in confidence giving full particulars of qualifications and experience to BOX J 842, Offices of ENGINEERING.

CONSULTING ENGINEERS in Westminster have vacancies for young Electrical and Mechanical Engineers. Good prospects with interesting and varied work.—Please apply to BOX J 840, Offices of ENGINEERING.

GRADUATE ENGINEER required to take charge of development work on magnetic and electronic amplifiers for servo systems in Industrial control amplifiers.

Applicants should have completed their National Service and have had experience of servo techniques and magnetic amplifiers.

The post is permanent and pensionable.—Apply in writing, marking envelope "B.4," to :—
PERSONNEL MANAGER,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
TRAFFORD PARK, MANCHESTER, 17. J 764

SITUATION WANTED.

SENIOR PRODUCTION MANAGER, M.I.I.A., M.I.Prod.E., M.Inst.W. (London) (at present responsible to Managing Director) of proven executive ability, sound knowledge of medium and heavy engineering, open to engagement shortly. Age 50. Would be grateful to receive offers relating to Working Directorship or suitable Managerial appointment.—Replies to BOX J 756, Offices of ENGINEERING.

Classified Advertisements continued on Page 88

AGENCIES.

ENGINEERING AGENTS wide experience and excellent connections, are prepared to follow up quotation in the South Wales area.—BOX G 551, Offices of ENGINEERING.

L. MANLIO GAVINO & CO., Engineers established in La Spezia, Italy, since 1912. In close contact with Italian Naval and Mercantile Authorities, Air Ministry and General Engineers, Would be willing to represent British Manufacturers specialising in modern electrical and mechanical plant and fittings. References given.—Write: LA SPEZIA (ITALY), Postal Box 87. G 580

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STEEL, ALUMINIUM, BRASS, SHEETS AND OFFCUTS, 10 to 24 G. Small or Large quantities. Cash payment.—DYAS & FOWLE, 41, Loudoun Road, N.W.8. MAI. 2711, 5477. G 577

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WE ARE BUYERS of all types of new ball and roller bearings in large quantities.—C.S.M., 39, AVENUE DE GENERAL LECLERC-LA GARENNE (SEINE), FRANCE. Telephone: CHA. 48-68. G 606

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HAND & POWER PRESS WORK

to 60 tons, capstan to 1 in.
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CAPSTAN AND CENTRE LATHES
MILLING
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WELDING (OXY-ACETYLENE, ELECTRIC AND ARGON ARC)
ASSEMBLY.

TATE BROS., LTD., PORTSLADE, SUSSEX. J 824

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BUTLER 9 FT. SWING MOTOR DRIVEN VERTICAL BORING MILL.
Table 7 ft. 3 in. dia. Two swivelling rams, rapid traverses. F. J. EDWARDS, LTD., 359, EUSTON ROAD, LONDON, N.W.1. EUSton 4681. G 611

TWW

BROWN & SHARPE HORIZ. MILLING MACHINE, table working surface 52 in. by 12 in.; single pulley drive; 16 spindle speeds, 17/390 r.p.m.
MILWAUKEE PLAIN HORIZ. MILLING MACHINE, table working surface 37in. by 12in.; single pulley drive; 15 spindle speeds, 18/360 r.p.m.
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KENDALL & GENT VERTICAL MILLING MACHINE, tee-slotted table, 39 in. dia.; 18 spindle speeds, 17/256 r.p.m.; 410/3/50 supply.

THOS. W. WARD LTD.,
ALBION WORKS SHEFFIELD
'Phone: 26311 'Grams: "Forward"
LONDON: BRETTENHAM HOUSE, STRAND, W.C.2.
'Phone: TEMple Bar 1515 (12 lines).
Remember — Ward's might have it! G 60

KEARNS NO. 3 STANDARD HORIZONTAL BORING AND FACING MACHINE with 28-in. facing head. Main table 54 in. by 36 in., revolving table 36 in by 36 in. Vertical verniers. Max. spindle to brace 6 ft. 9 in. Motor drive.

H. BELL (MACHINE TOOLS) LTD.
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NEW BESCO ALL STEEL OPEN ENDED PRESS BRAKE, Type E, Size No. R.150/8. Pressure 150 tons. Capacity 96 in. by ¼ in. Gap depth 12 in. Stroke 3 in.
BESCO UNIVERSAL SWING BEAM FOLDING, BENDING AND BOX FORMING MACHINE. Capacity 49 in. by 14 gauge. Smallest trunk formed round the beam 6¾ in. by 7½ in. high.
DOUBLE ENDED DOUBLE GEARED PUNCHING AND SHEARING MACHINE. Shears plate up to approx. ½ in. thick. Punches ¾ in. dia. by approx. ½ in. thick.
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BRADLEY & CRAVEN GEARED OPEN ENDED UNDERCRANK GUILLOTINE. Automatic hold-down, adjustable gauges. Capacity 84 in. by ¼ in. Gap depth 4½ in. Weight about 75 cwts.
NEW BESCO ALL STEEL UNIVERSAL FOLDING MACHINE, Model 418. Capacity 48 in. by 18 s.w.g. mild steel. Lift of clamping beam from bed 2½ in.
Photographs of the above are available.
MACHINE TOOLS, NEW AND USED. Of Every Description. Attractive Prices.

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Telephone: EUSton 4681-3771,
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LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone: Central 7606-7. G 552

PENSOTTI 5ft. Motor Driven High Speed VERTICAL BORING MILLS

with taper turning and screw cutting attachment. Max. swing 62 in. dia. Rapid power traverses. 16 speeds from 4 to 145 r.p.m. Motor 28 h.p. Approx. weight 10 tons. 1951-2 machines in excellent condition.

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COLES MODEL S.87 6-TON MOBILE CRANE. Diesel/Electric. Pneumatics.—C.I., LTD., STAFFA ROAD, LEYTON, E.10. LEY. 3678. J 694

8½ TONS RANSOMES & RAPIER "SUPER" TYPE MOBILE CRANE. Petrol or Diesel-Electric. Solid tyres. First class condition.—C.I., LTD., STAFFA ROAD, LEYTON, E.10. LEY. 3678. J 693

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EDWARD RUSHTON, SON AND KENYON (Est. 1855.)
AUCTIONEERS, VALUERS AND FIRE LOSS ASSESSORS OF ENGINEERING WORKS, PLANT AND MACHINERY.
YORK HOUSE, 12, YORK ST., MANCHESTER, 2.
Telephone: Central 1937/8.
Telegrams: Russonken, Manchester. G 609

PATENTS.

THE PROPRIETOR OF BRITISH PATENT NO. 643237, for "BLOWER FOR BLACKSMITH'S FORGE," desires to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from MARKS AND CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. J 817

THE PROPRIETOR OF BRITISH PATENT NO. 680961, for "CIRCULAR ANNEALING INNER COVER," desires to enter into negotiations with a firm or firms for the sale of the patent, or for the grant of licences thereunder. Further particulars may be obtained from MARKS & CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. J 841

THE PROPRIETORS OF PATENT NO. 594835 for "METHOD FOR THE PREPARATION OF WOOD PULP," desire to secure commercial exploitation by Licence in the United Kingdom. Replies to Haseltine Lake & Co., 28, SOUTHAMPTON BUILDINGS, CHANCERY LANE, LONDON, W.C.2. J 733

THE PROPRIETOR OF PATENT NO. 582949 for "PROCESS AND APPARATUS FOR PRODUCING STAPLE FIBERS," desires to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake and Co., 28, SOUTHAMPTON BUILDINGS, CHANCERY LANE, LONDON, W.C.2. J 734

THE PROPRIETOR OF BRITISH PATENT NO. 679647 for "IMPROVEMENT IN OR RELATING TO CIRCULAR SAW-BLADES," desires to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from MARKS & CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. J749

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LATTICE STEEL ERECTION MASTS (light and heavy) 30 ft. to 150 ft. high, for immediate hire. —BELLMAN'S, 21, Hobart House, Grosvenor Place, S.W.1. G 72

MISCELLANEOUS.

DRAWING OFFICE MANAGER—5 seconds to extract one drawing from amongst 1,000 ? 5 seconds to put it back into place ? That is **PLANSTORE.** —Please write for literature to RANDALRAK LIMITED, 106, Victoria Street, S.W.1. G 589

THOS. W. WARD LTD.
ALBION WORKS, SHEFFIELD
G 556

SOAG

OFFER FOR STOCK DELIVERY, THE FOLLOWING

HORIZONTAL BORERS

KEARNS MODEL OA. Motor drive, facing head, power feeds and rapid power motion to table and spindle slide, screwcutting and verniers, dia. of spindle 2½in., travel of spindle 18in., morse taper in spindle No. 5, main table size 33in. by 24in. (top table 24in. by 24in.), max. distance table top to centre of spindle 18in., max. distance spindle nose to outer support 54in., 16 spindle speeds 10 to 400 r.p.m. H.P. motor 5.

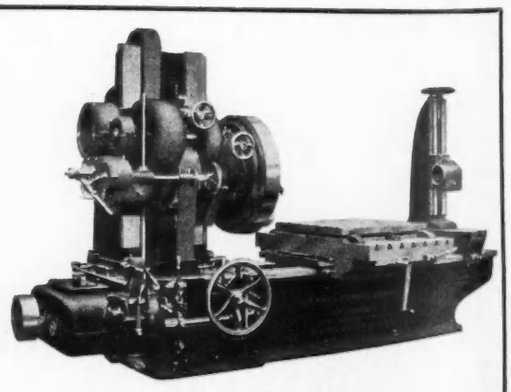
KEARNS No. 2 PATENT TYPE. Motor drive, with traversing spindle and continuous automatic facing head, main table with detachable quartering table, vernier scales, outer boring stay. Spindle dia. 3in., facing capacity 30in., main table 48in. by 30in., auxiliary top table 36in. by 36in., spindle to main table 23½in., 24 spindle speeds 3·1 to 250 r.p.m. H.P. of Motor 5.

SCHARMANN HBSF3. Motor drive, facing head, power feeds and rapid power motion to table and spindle, screwcutting and verniers. Dia. of spindle 4in., travel of spindle 31½in., facing cap. 39½in., boring capacity 19½in., working surface of table 47½in. by 55½in., max. distance spindle nose to outer stay 102½in., 24 spindle speeds 4·7 to 960 r.p.m. H.P. of Motor 10.

PEARN-RICHARDS No. 4. "Standard type" machine with facing head only, motor drive, rapid power traverses, facing capacity 48in., vertical adjustment above sliding table 12½in. to 40in., sliding table 60in. by 36in., revolving top table 36in. by 36in., max. distance spindle nose to stay 91in., 32 speeds 1·5 to 160 r.p.m., 8 feeds 8 to 100 c.p.i. (As illustrated.)

NILES FLOOR TYPE MODEL WV8. Flanged motor drive, all geared traversing spindle 3½in. dia. continuous facing head 24½in., travel of spindle 31½in., travel of column 52in., size of bedplate 114in. by 35in., distance baseplate to spindle max./min. 60in./18in., 16 spindle speeds 3 to 350 r.p.m. H.P. Motor (2 speed) 10.

● ***Send for further details of these machines***



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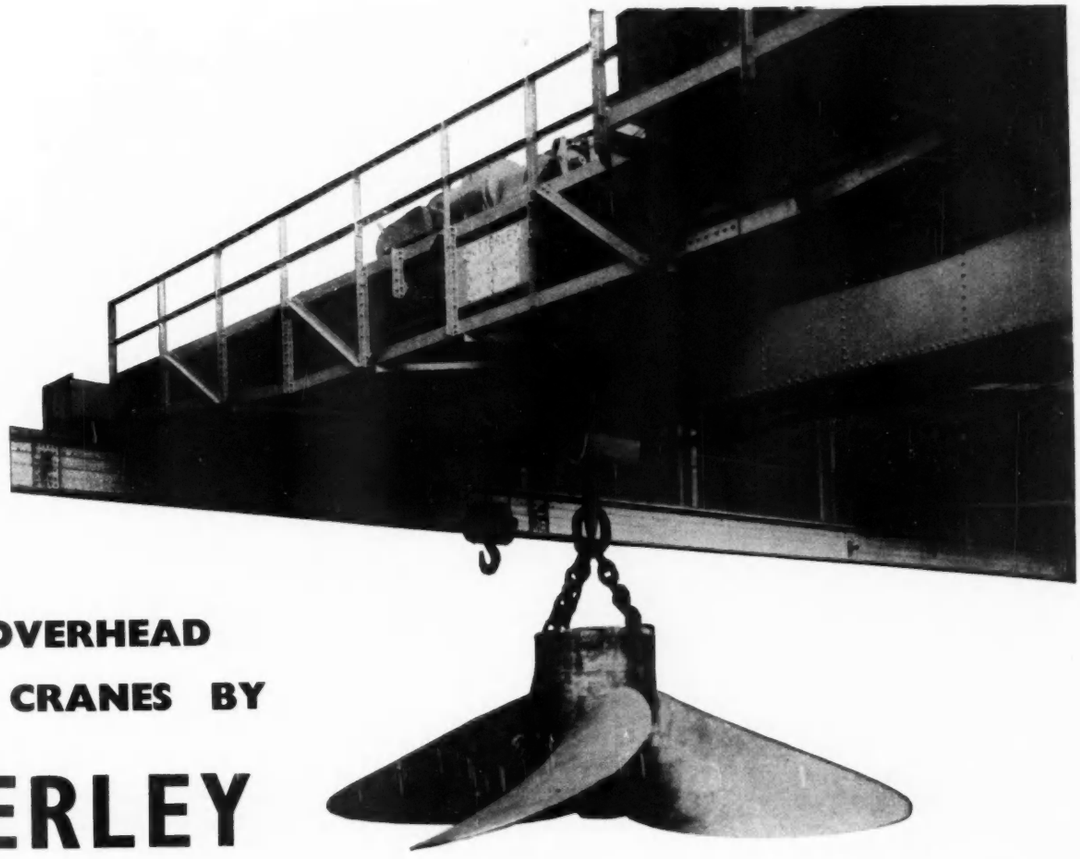
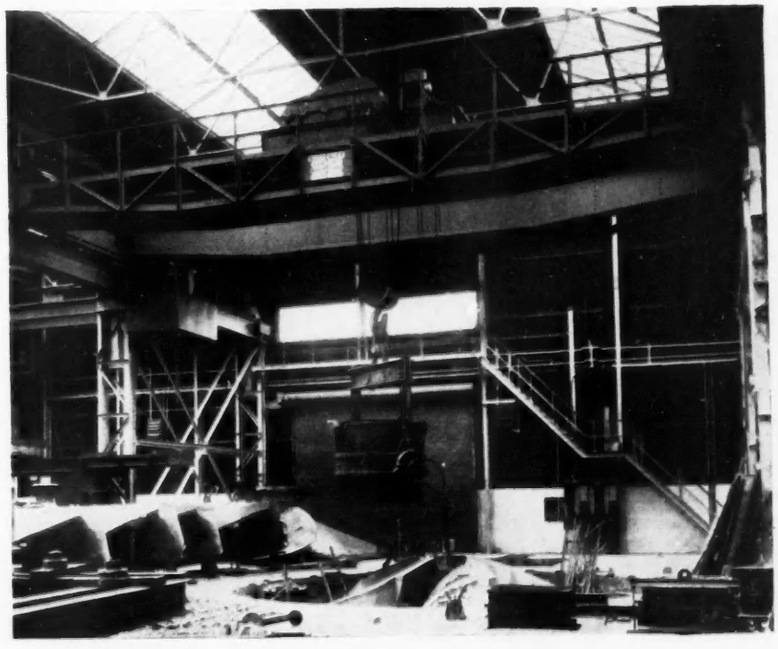


ELECTRIC OVERHEAD TRAVELLING CRANES BY

BUTTERLEY

This propeller casting, weighing approximately 35 tons, is being lifted by a Butterley crane which has a lift of 45 tons, with an auxiliary lift of 10 tons. The lower illustration shows the crane installed in the foundry of the Manganese Bronze and Brass Company Ltd., Birkenhead, where it was tested to 150 per cent. of the working load.



Since these photographs were taken, orders have been received for three more cranes of similar capacity.

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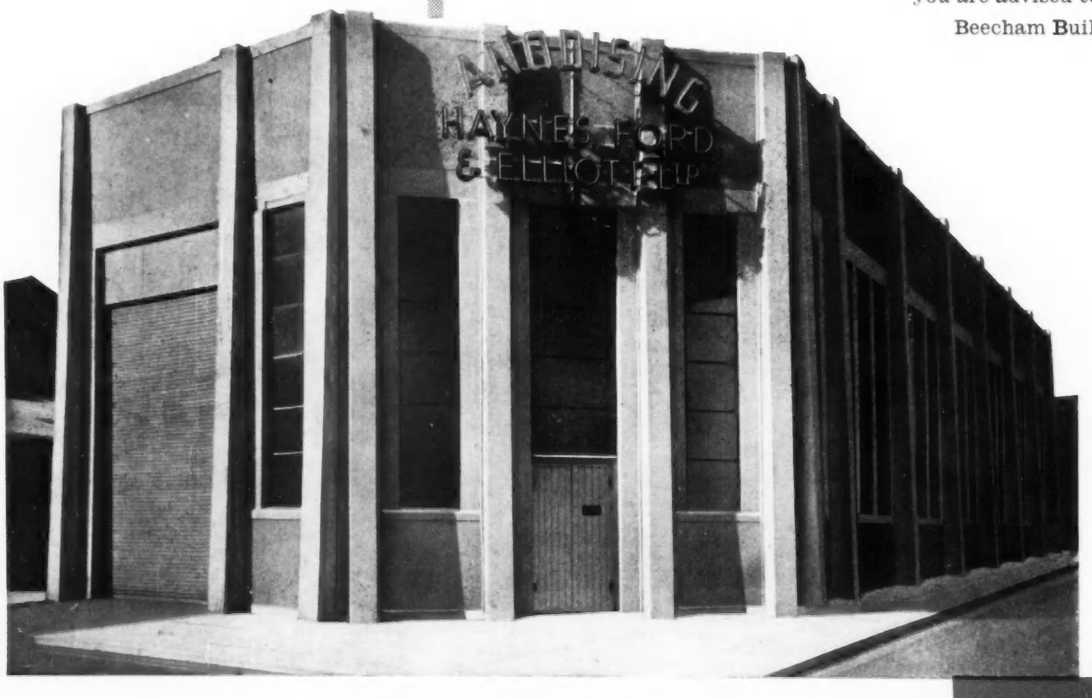

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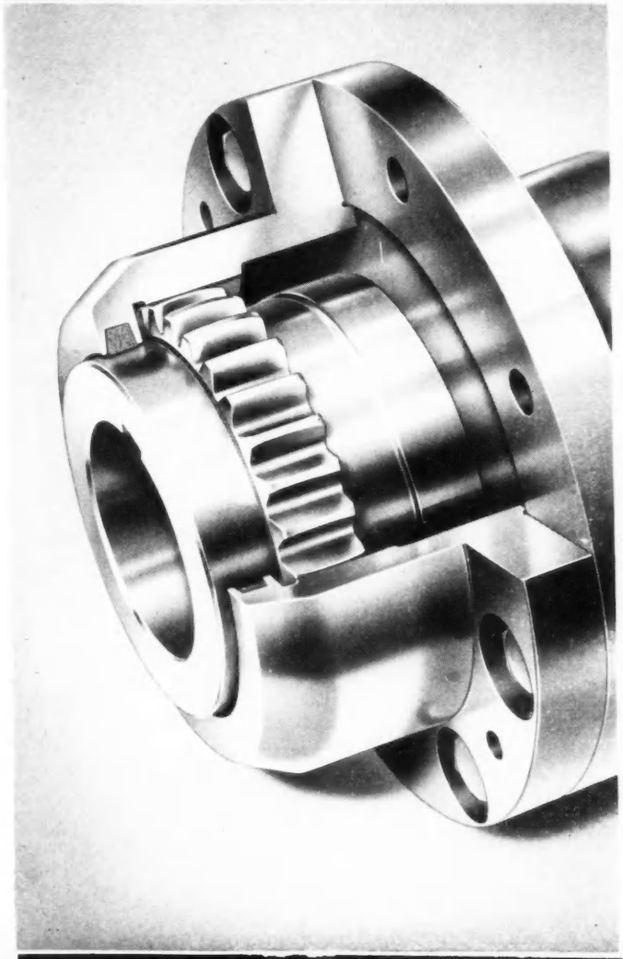

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